THE SCOTTISH HORTICULTURAL RESEARCH INSTITUTE

FIFTH
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A view of the main buildings from the south

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THE SCOTTISH HORTICULTURAL RESEARCH INSTITUTE

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THE DIRECTOR'S REPORT

Through the retirement this year of Major-General D. N. Wimberley, the Governing Body lost one of its strongest personalities and a man who participated vigorously in the affairs of the Institute. Appointed in 1951 and Convener of the Staff and Research Committee since its inception, General Wimberley's acumen and technique of interviewing are not readily forgotten by colleagues and candidates alike. But it is especially his aid to the Institute during its early years that should be recorded. From 1951 to 1953, when the Institute was virtually homeless, General Wimberley, in his capacity as Principal of the then University College, Dundee, provided it with temporary headquarters and ensured the continuity of the work started by the A.R.C. Scottish Raspberry Investigation. His desire for a close tie between the Institute and St. Andrews University led to the appointment, in 1954, of the Director and his senior members of staff as honorary lecturers in the University.

The appointment of Principal G. S. Hendrie, of the West of Scotland Agricultural College, to the vacancy thus created seems particularly apposite. For many years the College has been associated with Mr Reid's strawberry breeding work at Auchincruive and the appointment of its Principal means that all three of the Scottish Agricultural Colleges are now represented on the Governing Body.

Professor J. H. Burnett succeeds General Wimberley as Convener of the Staff and Research Committee.

THE YEAR 1957/58

Perhaps the most obvious trend of this year's Report is the increasing emphasis on plant breeding as a means both of combating diseases and of producing new varieties of crop plants suited to northern conditions and to the special needs of the processing industries. Work on the breeding of strawberries resistant to red core disease has continued at Auchincruive. The breeding programmes at Mylnefield are to include studies on the inheritance in raspberry of resistance to aphid-and soilborne viruses, in addition to the attempts now being made to produce raspberry seedlings of improved commercial qualities and black currants that resist spring frost damage and ripen evenly. Experimental evidence that the growing season is shorter and more intense in the north than in the south of Britain has been obtained and lends point to the amount of variety trial work being done by the Institute, particularly with vegetables. Many of the most successful vegetable strains have come from parts of Europe that have a climate similar to our own. Many new kinds of vegetables have been under observation and some promise to be useful additions to the range of crops that may successfully be grown in Scotland for processing.

Scottish raspberry growers may find comfort in the confirmation, by experiments, of the wisdom of some of their cultural practices. All the

stocks of raspberries now being propagated and distributed under the aegis of the Department of Agriculture for Scotland are virus-free. Cold-storage of strawberry runners for planting in summer seems a promising new development and the factors affecting the flowering of the strawberry are becoming understood. Studies on the inheritance of June Yellows and similar abnormalities in strawberry are continuing and the conditions affecting the incidence and spread of grey mould (*Botrytis cinerea*) in strawberry and raspberry are being investigated. Soilborne viruses continue to be the main interest of the virologists. The general features of such viruses have been established and work is now concentrated on discovering how they are transmitted through the soil.

BUILDINGS

The new glasshouse block was completed by the contractors in late autumn and made ready for occupation in January. Members of the Laboratory Service Section and the outdoor staff did the electrical work and erected the benches. The block comprises eight timber houses of standard design. One house each has been allocated to the Genetics, Mycology, Pomology and Vegetable Culture Sections; two are reserved for the propagation of virus-free raspberry plants and one of these is equipped with a propagation pit and mercury vapour lamps. A high-humidity inoculation chamber was designed and installed in the Mycology Section's house. So much of the older glasshouse range is taken up by work on plant virus diseases that there has been little room to spare for other kinds of work and the advent of the new range should relieve some of the congestion which has been developing in the last two years.

Facilities for the work of the Mycology Section were greatly improved by the provision of a fully equipped sterilising and preparation room and a sterile transfer and tissue culture room in the main laboratory building. A satisfactory level of sterility is maintained in the culture room by slight pressurisation with air delivered through a particulate filter, in conjunction with double doors and an airlock. Four controlled environment cabinets, designed by the Crop Physiology Section for experimental work with strawberries, were built by the Institute's Laboratory Service Section.

FARM AND PLANTATIONS

Although the bulk of this Report records the achievements and progress made by the technical staff, much of this work would not have been possible without the aid of the Farm Manager and his staff. Despite the increasing demands for land for experimental use and the need to adapt the cropping programme to these developments, the farm had a successful year.

The wet summer interfered with the grain harvest, and the barley and some of the oats had to be combine-harvested. The yields of barley and oats were below average but the winter wheat gave an excellent crop. Sugar-beet did extremely well and the crop, 13 tons/acre with a sugar content of 16%, was the best yet recorded. This year a mechanical harvester was hired and the crop, over 200 tons of roots, was efficiently cleared in a week.

An innovation this year was the decision to buy beef cattle attested under the Tuberculosis (Attested Herds) Scheme. Only some of the animals were fully-attested and the rest once-tested, but in future only fully-attested store bullocks will be bought. During the year, 59 bullocks were fattened, 37 of these entirely on grass.

The weather was very broken during the fruit season but the crops were good; 5½ tons of strawberries, 22 tons of raspberries and almost a ton of black currants were sold. Some of the oldest raspberry experiments, planted in 1951, were ploughed out during the winter. The new plantings, made in East Loan in spring 1957, were posted and wired and should crop in 1958. Marketable produce from the vegetable experiments included cabbage, peas, French and broad beans but the largest crop was brussels sprouts, of which 4½ tons were sold.

Wind continues to be a major hazard to experimental crops and glass. Autumn gales damaged the older poplars along the east service road to such an extent that some had to be replaced and all pollarded. Another wind break of deciduous and coniferous trees was planted, this time along the west boundary of Bullion South. Other improvements included the removal of the grass bank and dyke foundation separating Laboratory and West Laboratory fields and the sowing of the lawns adjoining the main building.

The equipment of the Farm and Glasshouse Sections was augmented and increased use was made of the workshop during the year.

STAFF

In November, D. L. Jennings, formerly Plant Breeder to the East African Agriculture and Forestry Research Organisation, was appointed to the post in the Pomology Section vacated by Dr Acheson (Dr Sudd) in 1955. His work will be concerned with raspberry breeding, in particular a study of the inheritance in raspberry of resistance to infection by soilborne and other viruses. D. W. Burd returned from sick leave in July and D. Willis, who had temporarily replaced him, left in August. By arrangement with the R.A.F. authorities at Leuchars, Fife, D. Cranston again helped as a voluntary worker for one day a week during much of the year.

B. D. Harrison left the Virology Section in November to take up an appointment in the Plant Pathology Department, Rothamsted Experimental Station. In April, Katherine Forbes and in May, Patricia Duncan were appointed as Assistants (Scientific) in the Mycology and Virology Sections respectively.

A. G. Fisken gained the degree of Ph.D. in the University of St. Andrews for a thesis entitled "Studies in the ecology of potato aphids in eastern Scotland with special reference to *Myzus persicae* (Sulzer)." J. P. Sutherland passed the final examination for the National Diploma in Horticulture.

OTHER ACTIVITIES

C. H. Cadman and R. M. Lister attended the 3rd Conference on Potato Virus Diseases held in July in the Netherlands. Dr Cadman read papers by B. D. Harrison and himself on soilborne viruses in potato. Afterwards, he and Dr Harrison visited centres in Germany where work on plant viruses and

virus diseases is being done. In August A. R. Wilson attended the Inaugural Meeting of the European Association for Potato Research in Sweden. Through the kindness of Professor G. E. Blackman, J. P. Sutherland spent three weeks with the A.R.C. Unit of Experimental Agronomy, Oxford, acquiring experience of the materials and techniques used in the chemical control of weeds. Miss Weaver spent a week at the Royal Forest Factory, Coleford of Messrs H. W. Carter & Co. Ltd. learning the technique of estimating the vitamin C content of black currant fruit.

Several lectures were given to growers and papers read to scientific societies by the Director and other members of staff. Aspects of the Institute's work were illustrated by exhibits staged at the Royal Highland and Agricultural Society's show in Dundee, the spring show of the Royal Caledonian Horticultural Society and at an evening Conversazione of the Institute of Biology in Aberdeen.

Among overseas visitors to the Institute this year, we were particularly glad to welcome those from the Netherlands—Professor E. C. Wassink, Miss H. G. Kronenberg, Mr J. D. Gerritsen and Mr B. Roelofsen. Those from the Commonwealth included Mr N. J. Adamson of the New Zealand Department of Agriculture, Mr D. Martin of C.S.I.R.O., Tasmania and Dr N. S. Wright of the Plant Pathology Laboratory, Vancouver. Mr A. L. Eloja of the Bureau of Plant Industry, Manila, spent a month working in the Virology Section. Visitors from the United Kingdom included members of the Scottish Advisory Committee on Standard Grades and Packs for Fruit and Vegetables. About 100 visitors came to the Growers' Day held on July 13th but few to a second meeting held in September.

ACKNOWLEDGMENTS

In the assessment of processing quality of fruit and vegetable varieties help has been given by the British Food Manufacturers Research Association, Leatherhead; Messrs Chivers & Sons Ltd., Montrose; Messrs John Morrell & Co. Ltd., Dundee; Messrs Smedley's Ltd., Dundee, and the Ministry of Agriculture, Fisheries and Food's Experimental Factory, Aberdeen. Many gifts of seeds and plants were received from centres overseas and others at home, including the East Malling Research Station, the John Innes Horticultural Institution and the National Fruit Trials. Mr Storrie kindly provided fruit trees for distribution to the staff. Dr W. C. Swanson and Mr J. McKie of the Physics Department, Dundee Royal Infirmary, helped with work on the irradiation of raspberry and black currant material and the Pomology Section collaborated also with the Edinburgh and East of Scotland College of Agriculture in work on the control of bacterial canker in plums. Mr E. F. Trickett, National Institute of Agricultural Engineering, Silsoe, and Mr M. J. Blackwell, Superintendent of the Eskdalemuir Observatory, advised on the problems of recording light intensity. The Institute is indebted to the Department of Statistics, University of Aberdeen and the Statistics Section of East Malling Research Station for assistance with the design and statistical analysis of experiments, and to the Chief Surveyor of the Department of Agriculture for Scotland and his staff who prepared the Institute's Annual Farm and Plantation Cropping Record and the map reproduced in this Report.

POMOLOGY

C. A. Wood

The 1957 fruit season was the earliest at Mylnefield for several years. Raspberries flowered from ten to 15 days earlier than in 1956 and ripened from nine to 11 days earlier, and other small fruits behaved similarly. Spring frost damage, especially to raspberries, was the worst in the station's short history, but even so was largely confined to the lower-lying plantations and only seriously affected the yield of black currants and the raspberry Lloyd George. The weather in the picking season was generally good. Following an almost frostless winter, it was a very difficult year for weed control: chickweed and other ephemerals were growing and flowering for some time before spring cultivations could begin.

PLANT BREEDING

Raspberries

Nine families raised from seed in 1953 and 1954, all of them intervarietal crosses having either Malling Jewel or Malling Exploit as one parent, were re-assessed and a further 31 seedlings selected. Selection was based on the presence either of several desirable characters in combination or of outstanding single characters, such as firmness of fruit texture, good colour or ease of plugging. First assessments were made of four more families raised from seed in 1955, all intervarietal crosses involving the East Malling seedling 64/53. Seedling families of three further such crosses made in 1956 were raised and planted out.

Thirty-four families, consisting of more than 3,000 seedlings, were planted as part of the longer-term programme of inbreeding referred to in the last Report. These were produced in 1956 by the self-pollination of a range of red raspberry varieties and unnamed seedlings which included thirteen selections from the Malling Jewel and Malling Exploit crosses mentioned above. Owing to poor germination, some of the inbred families are at present small: the more forward of the seedlings planted should fruit in 1958 but the detailed recording of most will not be possible until 1959.

Pollinations made in 1957 included two more intervarietal raspberry crosses, thirty-nine exploratory crosses between the red raspberry and other species of *Rubus*, and repetitions of seven of the self-pollinations made in 1956: nine *Rubus* species were also self-pollinated. Most of the interspecific crosses gave useful amounts of seed but it is not known to what extent apomixis may have occurred. The seed of all these families was sown in December. (D. W. Burd, W. Fordyce.)

Black Currants

The main objectives of the black currant breeding programme were described in the last Report. Twenty-eight families raised during the year from

the seed produced in 1956 included intervarietal crosses of black currant, crosses between black currant and other species of *Ribes*, and families obtained by self-pollinating a selection of black currant varieties. Nearly 4,000 seedlings were lined out in nursery rows but most of them will not fruit until 1960.

Fifteen new intervarietal crosses were made in 1957. Several of these involved the Canadian varieties Magnus (for evenness of ripening on the strig) and Consort (for reputed ready self-pollination in the absence of insect activity), whilst in others the varieties Tinker (for sweetness and palatability) and Laxton's Giant (for size of berry) were used. Thirteen interspecific crosses were made, some within the *Eucoreosma* (black currant) sub-genus of *Ribes* but the majority between black currant varieties and selected species from other sub-genera, chiefly *Ribesia* (red currants). Five black and four red currant varieties were self-pollinated. The intervarietal crosses and most of the self-pollinations gave plentiful seed. The fertility of the interspecific crosses varied, but with reasonably good germination the seed from most should be enough for a useful assessment of the hybrids.

In the further development of this programme, emphasis will continue to be placed on obtaining improved spring hardiness and greater evenness of ripening. Attention will also be paid to possible sources of resistance to specific diseases and pests, especially leaf spot disease (*Pseudopeziza Ribis*). Concentration in the immediate future will be on further exploratory interspecific crosses and the self-pollination of any other *Ribes* species, besides the cultivated currants, that are thought to have breeding value. (M. M. Anderson and W. Fordyce.)

THE CULTIVATION OF RASPBERRIES

The purpose of this second main section of work is to evaluate the effects of the numerous cultural factors that influence the performance of raspberry plantations. The earlier experiments on this subject, concerned with non-manurial factors, are gradually being completed and the planting of a new series began in spring 1957. These now occupy about eight acres and are concerned primarily with nutritional factors, but they are so designed that some of the treatments used in the earlier experiments can be introduced in order to test them at different manurial levels. In addition, an experiment was planted with Lloyd George and Malling Jewel to compare the performance of virus-free stocks (obtained by heat treatment) with that of the mildly virus-affected stocks hitherto distributed by the Institute as the best available. Yields were recorded in 1957 from the newly-planted canes of all these experiments, but at least one more year's work is necessary before results of any interest can be reported.

The first experiment of the earlier series, on planting distances and heights of winter tipping of canes, was concluded in the autumn. The seven years' results showed that, within the range of planting distances tested ($5\frac{1}{2}$, 7 and $8\frac{1}{2}$ ft. between rows and 2, $2\frac{1}{2}$ and 3 ft. between stools within the row) and with the varieties used (Malling Promise, Lloyd George and Norfolk Giant), yields per acre declined as row distances widened. This was true notwithstanding the better growth and productivity of the individual plants at the wider distances. For the first three seasons, yields per acre increased as inter-

stool spacings decreased, but this factor afterwards lost its effect as competition depressed the cane production of the closely-spaced stools. However, the most consistent results from year to year were from the tipping treatments. Sub-plots were tipped in most winters at 4, 4½ and 5 ft. above soil level, and each increase of height regularly gave a substantial increment of yield. There were indications that the advantage of higher tipping was least in Lloyd George and least, for all three varieties, at the widest (8½ ft.) row distance. Assuming the aim to be maximum yield per unit area, the results of this experiment suggest that on normal terrain and where suitable equipment is available there is no advantage in spacing raspberry rows more than 6 ft. apart. Canes should be winter-tipped at the highest level at which pickers can still reach the topmost fruit: this, under our conditions, is considered to be about 5 ft.

In the experiment to compare the value of planting canes singly with planting in twos ("double" planting), started in 1952, the year's results were erratic in that two of the varieties cropped better on the originally double-planted plots and the other two on the single-planted, but the differences were fairly small, and the margins of yield established in favour of the double-planted plots during the first four years of the experiment remained largely unaltered.

The experiment with Malling Promise and Lloyd George on frequency of picking and numbers of canes fruited per stool, also begun in 1952, again showed that the crop increased with each increase of cane number. The numbers compared were 6, 7, 8 and 9 per stool, one more at each level than in 1956. There was again no significant difference between the yields obtained by picking at four-day and at two-day intervals. The effect of increasing the numbers of canes per stool has been very consistent in this experiment during the four years in which this factor has been tested. Some of the cane populations fruited have been higher than are normal in commercial practice, but it is not yet known what effect density of fruiting cane population may have on the productive life of a plantation, nor how it is related to manurial practice.

The experiment to compare alternative methods of treating the tops of canes (var. Malling Promise) in winter, again gave a heavier crop where the cane tops were arched over at tipping height and re-tied to the top wire than where they were tipped in the ordinary way. The respective yields were 103 and 89 cwt./acre. In contrast with some previous years there was no difference in yield between canes tipped at the normal time and those tipped after bud-burst, nor between canes arched-over and tipped below the top wire and those similarly trained but left unshortened. This experiment is being continued and the same treatments are being repeated on a two-year-old experiment planted with Norfolk Giant (see below).

Previous Reports have referred to three experiments planted in 1954. Two of these are concerned with systems of training alternative to the post-and-wire method and the third with the normal Scottish practice of maintaining raspberry plants as separate stools as opposed to allowing the rows to form continuous "hedges" of non-stooled canes. These experiments are now producing detailed information on relationships between cane populations and yield under the different cultural treatments. It seems probable that, even with equally good weed control, the "hedge" system is a less productive method of

growing raspberries than the stool system. Non-stooled rows, even when kept narrow, become too thickly populated with canes; many of these are rather late in starting to grow and the general quality of the growth tends to be inferior. The experiments on systems of training clearly showed in 1957 the cropping superiority of posted-and-wired rows over those in which the canes were either tied together in vertical bunches or arched over from stool to stool. The arched-over rows gave the poorest yields, due partly to the greater damage they suffered from radiation frosts in the spring. This damage appeared to be associated not so much with the lowness of the arches as with the fact that under this training system a high proportion of the flower buds become directly exposed to the sky.

The remaining experiments mentioned in past Reports are two planted in 1955/56. One has compared the performance of canes lifted at successive dates in autumn and winter and planted in spring, the other the autumn- and spring-planting of autumn-lifted canes. The variety in each is Norfolk Giant. These are cultural practices which may be expected to show their effects, if any, in the early years of a plantation, and the effects may well vary with soil and other environmental conditions, including the weather during the winter of lifting and planting. Such experiments must therefore be repeated at least twice before conclusions can be drawn. The present two have now been converted to new uses, one to a further trial of treatments of cane tops (see above) and the other to a chemical herbicide trial. It will still be possible to estimate effects of the original treatments, should they persist, and repetitions of both experiments (each with the varieties Lloyd George and Malling Exploit) are being planted in 1957/58.

The experiments in the fruit cage again gave useful results, in general confirming those of 1956. It is planned to continue them for either one or two more years. (C. A. Wood, M. M. Anderson, W. Fordyce, J. P. Sutherland, B. Tulloch.)

CHEMICAL WEED CONTROL

Experiments on the use of chemical herbicides in raspberry plantations were continued, again mainly in cane nurseries. The materials tested for the first time at Mylnefield were 2, 4-DES (sodium 2- (2, 4-dichlorophenoxy) ethyl sulphate), DNBP (2- (1-methyl-n-propyl) -4, 6-dinitrophenol), TCA (trichloroacetic acid) and neburon, a substituted urea. 2, 4-DES gave very successful results, particularly against groundsel (*Senecio vulgaris*); the results with DNBP were promising. TCA, used at 20 lb./acre in combination with DNBP, caused a temporary distortion and a persistent veinal chlorosis in raspberry leaves. The tests on neburon were too limited to be useful.

In continuation of previous work, phenyl carbamates (IPC and CIPC) and pentachlorophenol (PCP) were each tested in combination with 2, 4-DES in an attempt to find a mixture to control a wide range of weeds. The most successful combination was IPC and 2, 4-DES, applied together to ground recently cleaned. The IPC controlled chickweed (*Stellaria media*) and annual meadow grass (*Poa annua*), and the 2, 4-DES groundsel and shepherd's purse (*Capsella bursa-pastoris*). These were the main weeds present. Each material was applied at 2½ lb./acre, but this rate was not necessarily optimal

for either. A mixture of CIPC and 2, 4-DES was also effective as a herbicide but severely injured young raspberry canes in a nursery. It may have some value for fruiting plantations.

The past three years' work has shown that it should be possible by means of chemical herbicides to reduce the frequently high cost of weed control in raspberry cane nurseries, and it is likely that materials found to be effective in a nursery will serve for fruiting plantations also. Further materials will be tested in 1958 in raspberry plantations of both kinds and on strawberry runner-beds. (J. P. Sutherland.)

STRAWBERRY INVESTIGATIONS

Trials of new Auchincruive seedling selections are being continued in co-operation with the West of Scotland Unit. The selections received each year since 1954, usually as four-plant units for planting in August or September have varied in number to upwards of one hundred. The few of these that survive the next stage of selection at both stations are propagated and re-planted as 15- or 30-plant units for further assessment.

In the year of release of any new strawberry variety by the Institute, it is now the practice to establish a fairly large plantation of it at Mylnefield in order to have a fruiting bed at least as old as any in commerce. The cropping performance of this can be recorded and a watch kept for any faults or unusual features that may be reported from elsewhere. The present plantations of this kind are of Talisman (1955) and Redgauntlet (1957). (C. A. Wood, M. M. Anderson.)

APPLE VARIETY-ROOTSTOCK TRIALS

These trials of bush apples are now entering their fifth year. Their purpose is to assess the behaviour in Scotland of rootstocks of the Malling and Malling-Merton series and to test a number of dessert and culinary varieties which may serve as standard types, representing certain periods of flowering and seasons of maturation under our conditions.

The growth of the trees in 1957 was satisfactory, and there was less damage from wind and other physical causes than in previous years. Measurements of stem girth have now been made for three years, and although the trees are still very young these records are beginning to show small but consistent trends associated with rootstocks and varieties. Although fruit yields so far have been small, the trees are responding to the lighter pruning of the past two winters.

The trial to compare the two vigorous rootstocks M.XVI and M.XXV was extended by the addition of the variety Bramley's Seedling, and preparations were made to add a trial of dwarf pyramid trees to the series. (D. W. Burd.)

OTHER VARIETY TRIALS

Red Currants

The red currant trials and observation plots planted in autumn 1955 gave their first fruit in 1957. The quality was good but no useful comments can be made on yields. Several bushes were badly damaged by high winds in the summer.

Black Currants

In the black currant variety and pruning trial, also planted in autumn 1955, the yields of the Finnish variety Brödtorp and of Seabrook's Black were notably good in spite of the frosty season. Differential summer and winter pruning treatments were applied for the first time. This and the older trial sponsored by the Scottish Fruit Trials Committee (see below) are now being used for a comparative study of the performance of the two classes of maiden shoot ordinarily present on a black currant bush, namely shoots arising at or below ground level (termed type A) and those borne above ground on two- or three-year-old wood (type B).

An extensive collection of named black currant varieties has been assembled during the past three years, partly as a lead to further variety trials in Scotland and also as breeding material. Bushes of 60 varieties, most of them British-named and raised from material obtained from the National Fruit Trials in England, were planted into fruiting rows in February 1958, and other varieties, including many of Russian and Scandinavian origin, are being propagated.

Plums

Nine more trees in the "elimination" trial of plum varieties and rootstocks died from bacterial canker in 1957. The growth of the remainder was generally good, and the gaps left by the losses of previous years were filled by maiden trees of other varieties received for trial, including several from Jugoslavia.

Twenty-six varieties cropped during the year, 14 of them for the first time, but the only appreciable yields were from Cox's Emperor, Czar, Giant Prune, Laxton's Cropper, Warwickshire Drooper and Wyedale. Wyedale and Thames Cross were not ready for picking until November 6th and 11th respectively, very late dates indeed for Scottish conditions. Most of the fruit picked was of better quality than in 1956, but that of Blue Rock and Cox's Emperor showed much splitting and rotting.

Apples, Pears, Cherries

Apples cropped rather poorly at Mylnefield in 1957, probably because of the sequence of weather and cropping of the two previous years. In the Variety Collection, 209 varieties fruited, 24 for the first time, but individual yields were low. Tree growth, however, was good. A further 104 varieties, including some received from Jugoslavia, are due to be added to the Collection early in 1958.

In the "elimination" trial of modern apple varieties on four Malling rootstocks, 76 varieties cropped, three for the first time. Only five of the total of 103 varieties have still to fruit. This trial and the older rows of the Variety Collection were sown down to a cover crop in late August with the same seeds mixture—mainly S50 timothy with white clover—that was used in 1956 for the Variety-Rootstock trials.

A progress report on the Apple Variety Collection and variety "elimination" trial, giving detailed records for the period 1952-1956, was submitted to the Scottish Fruit Trials Committee in April.

Eleven varieties in the Pear Collection cropped in 1957, seven for the first time. A further 69 varieties were planted in April.

The 1955 cherry trial made satisfactory progress. Wind damage was reduced by thinning the growth of lateral shoots in summer.

Scottish Regional Fruit Trials

These co-operative trials were continued. In the raspberry trial (planted in 1952) Malling Promise cropped best with $5\frac{1}{4}$ tons/acre, followed by Malling Exploit and Malling Jewel with slightly under five tons each. The striking contrast with all previous years was the very low yield of Lloyd George ($1\frac{1}{4}$ tons/acre), caused by frosting of the flower buds in spring. The recovery that this variety often shows, by a ready formation of secondary laterals, took place only poorly under the dry conditions of late May and early June. Samples of fruit from the trial were used for jam-making and canning tests.

Fifteen of the 16 varieties in the black currant trial (also planted in 1952) gave higher yields than in 1956, even though nearly all the varieties showed greater percentages of frosted flowers in spring and ripened fewer berries per strig. This result was due partly to the improved growth of the bushes, but a contributory factor was the large size to which the individual berries grew after heavy rain during the ripening period. Many of the fruits burst, and both ripe and green berries were badly attacked by *Botrytis cinerea*. Fruit from this trial was used for dehydration tests and determinations of ascorbic acid content at the Experimental Factory of the Ministry of Agriculture, Fisheries and Food at Aberdeen, and ascorbic acid assays were also made for the first time at Mylnefield.

A report* on this series of trials was published in December 1957 by the Scottish Agricultural Colleges and the Institute, on behalf of the Scottish Fruit Trials Committee. (M. M. Anderson, W. Fordyce, J. P. Sutherland, B. Tulloch.)

MISCELLANEOUS

An experiment to assess the value of a paint containing the antibiotic streptomycin as a protection against plum bacterial canker infection was started in co-operation with the Edinburgh and East of Scotland College of Agriculture and Dr A. M. Paton, of the Bacteriology Department, University of Aberdeen. One thousand Myrobolan B plum rootstocks were planted in the nursery in spring; 800 of these were budded in July with the variety Victoria, and paint treatments were applied to the successful bud unions on November 1st, shortly before leaf-fall occurred on the rootstocks.

In co-operation with the Chemistry Department of the Edinburgh College an experiment was undertaken to determine the fresh and dry weight and chemical composition of the waste and surplus cane material removed from raspberry plantations in the course of routine operations in autumn. This is of interest in relation to manurial practice. Useful information was obtained and the work will be repeated in 1958.

*Report on Fruit Trials in Scotland, 1949-1956.

PUBLICATIONS

ROBERTSON, MARGARET (1957). Further investigations of flower-bud development in the genus *Rubus*. *J. hort. Sci.*, **32**, 265.

(Dissections in the autumn and winter of 1953-54 showed that flower initiation began in seven forms of *Rubus* at the following approximate times: red raspberry (*R. idaeus*) var. Lloyd George, early September; black raspberry (*R. occidentalis*) var. Cumberland, mid-October; purple-cane hybrid raspberry (*R. idaeus x R. occidentalis*, a seedling of known origin), early to mid-September; loganberry (East Malling clone), mid- to late September; blackberry var. Himalayan Giant, mid-October; blackberry var. Ashton Cross, late March; blackberry (a local wild form), mid-March. These times refer to the primary (main) buds at cane nodes. Initiation generally began later in secondary buds and still later, if at all, in tertiary buds (small buds in the scale-axils of primary and secondary buds). The development of primary inflorescences reached a fairly advanced stage in autumn in the loganberry and in the purple-cane hybrid and red raspberries, but occurred mainly in spring in the black raspberry and in blackberries.)

WOOD, C. A. (1958). Apples at Mylnefield. *J. R. Caledonian hort. Soc.*, 1957, 42. (This article discusses the background of the apple investigations at Mylnefield, describes each of the trials now established, and reports present progress.)

VEGETABLE CULTURE

C. North

The experimental vegetable crops were grown in Strip field of North Bullion for the first time. The level of fertility of this area was low and after the mild winter of 1956-57 patches of heavy soil were still in poor tilth. As a result some crops, especially the transplanted brassicas, were less satisfactory than in previous years. However, none of the yield trials was seriously affected.

VARIETY TRIALS

French Beans

Nine varieties were again compared in a yield trial. Although the yield of the non-stringless variety Masterpiece was significantly higher than that of any other, the stringless-podded varieties, Double Princess (Hurst), Record (Ohlsens Enke) and Saxa (Zwaan and de Wiljes) were nearly as productive; Fiskeby (Weibull) and Konserva II (Weibull) were slightly less productive. Samples of pods were sent to Messrs Smedley's Ltd., Dundee, for canning and to the Ministry of Agriculture, Fisheries and Food Experimental Factory at Aberdeen for dehydration tests. The flavour of canned and freshly cooked pods of Konserva II (Weibull) was particularly good. Most of the samples sent for dehydration gave promising results.

Sixty-four varieties, including 34 from the Czechoslovak State Vegetable Research Institute, were grown in observation plots. Only one of the Czechoslovak varieties, Párathan Viasz, seemed to be suitable for Scottish conditions and even so it was inferior to those already being tested in the yield trial. Three varieties from other sources, Regina (Dippe), Contender (Hurst) and Mangetout Nain (Vilmorin), gave especially high yields of stringless pods and were chosen for inclusion in the 1958 yield trial. Mangetout Nain seems very similar to the Swedish strain Arla (Weibull), which was also grown in the observation plots.

Broad Beans

In view of the increasing popularity of broad beans for canning and quick-freezing, a yield trial was sown to compare 38 stocks, including the 35 already grown in observation plots in 1956. Seed was sown on April 10th and the beans began to mature during the third week of August. The crop grew well and there were few signs of disease, but about 1% of the plants showed virus-like symptoms which resembled bean leaf roll. The order of yield conformed closely to that of the 1956 observation plots; the highest yields of shelled beans were given by the varieties Bunyard's Exhibition (Cullen and Finney), Masterpiece (Cullen), Conqueror (Hurst), Hangdown (Ohlsens Enke), Extra Lange Afhangers (Rijk Zwaan), whilst Claudia and Seville Aquadulce types gave low yields.

Fresh seeds of most varieties are pale green in colour and turn brown when cooked. The white seeds of the varieties Triple White and Lux (Rijk Zwaan) are suitable for canning as they do not become discoloured in cooking. The varieties Masterpiece (Cullen), Giant Green (Cullen) and Robin Hood (Hurst), had particularly dark-green coloured seeds which may be especially suitable for quick-freezing. Strains differed in seed and pod characters as well as in other features such as habit of growth. For example, the plants of some stocks of the Seville types had such weak stems that they were unable to support the weight of the ripening pods.

Canning Peas

Of the varieties compared in the yield trial, Lincoln and Monarch Canner (Hurst) cropped best. Kelvedon Wonder again matured earlier and yielded better than Gregory's Surprise, the other early maturing variety included in the trial.

In addition to the yield trial, six varieties were compared in observation plots. The most promising of these were Early Alaska (Sharpe), which matured very early and had shorter straw and a more bushy habit than ordinary Alaska; Greenland (Sharpe), which matured very late; Express Freezer (Sharpe), which produced very sweet-tasting and dark-green peas and matured about the same time as Kelvedon Wonder; and Wiwo (Daehnfeldt) which was similar to a good strain of Witham Wonder.

Sugar Peas

Ten varieties were grown for observation. Three of them, Sylvester (Olson), Dvärg Sabel (Olson) and Buxbom de Grace (Weibull), formed dwarf plants which matured early; the other varieties gave medium- to tall-growing plants which were not ready for picking until mid-July. Plants of Dvärg Sabel differed considerably from those of the other nine varieties; they had purple flowers and no leaf tendrils. Early-maturing varieties might be useful for Scottish gardens since the plants reach the harvest stage before most early-maturing garden peas. The flavour of the pods varies with variety, but is never the same as that of green peas.

Brussels Sprouts

In the yield trial, 6% of the established plants wilted and died when they were about a foot tall. Losses were not uniform throughout the area and were significantly higher in Atlas Slusia than in any other variety. The symptoms were associated with the presence of *Phoma lingam* in the roots. Otherwise the crop grew well and the average yield per row of marketable sprouts was nearly as good as in previous years. The highest yields were given by Cambridge Special, The Cluseed and Grower B's strain.

Forty strains were grown in the 1957-58 observation plots. The varieties Marché de Berne (Vatter), de Rosny (Tozer), Roodnerf (Nunhem) and Barendrecht Glory (Rijk Zwaan) had very firm dark-green sprouts and were selected for further trial.

An instrument for measuring the degree of "firmness" of brussels sprouts was constructed and has given encouraging results. A sprout is held between the flat surfaces of two cylindrical pieces of metal 1 cm.^{2} in cross section and

the diameter of the sprout is recorded on a dial. A weight of 2 Kg. is then applied and the diameter is remeasured. Change in diameter expressed as a percentage of the initial diameter is taken as a measure of "firmness."

Summer Cabbage

Eighty-two strains of summer- and autumn-maturing cabbage were compared in observation plots, sown on April 11th. Plants of Forehead (Hurst), Early Head (Harrison) and Ditmarsh Extra Early (Sharpe) matured first and were ready for cutting on July 29th. The strain Canadian Acre (Tozer) was very uniform, the plants forming small round heads early in August. Plants of Oakview Ballhead (Ferry Morse) developed extremely firm egg-shaped heads of medium size, for harvesting in September and October. Heads of some of the autumn-maturing Amager strains put into store in an unheated barn in early October were still in excellent condition for marketing at the end of March. The possibility of growing strains of this variety for storing during the winter of 1958-59 is being investigated.

Samples of 15 autumn-maturing varieties were tested for dehydration at the Ministry of Agriculture, Fisheries and Food Experimental Factory at Aberdeen. The varieties Halvhøj Vinter (Hansen), Evergreen Hollander (Hansen) and Oakview Ballhead (Ferry Morse) gave the best results.

Broccoli

The six selections from the variety Royal Oak were again compared in a yield trial with a control variety St. George. After the very mild winter of 1956-57 the crop matured early and gave a high proportion of good curds. The yield of the control variety was significantly higher than that of any of the strains of Royal Oak. Another yield trial and observation plots of broccoli, including the late-maturing Roscoff types, were planted for harvesting in 1958. Plants of some varieties were severely damaged by frost in February 1958.

Spinach

Some effects of variations in the density of plant population on the growth of spinach were again examined. Seedlings, in rows spaced at 15 in., were thinned to distances of 1, 3, 6, 9 and 12 in. apart. As in 1956, plants 6 in. apart gave the highest total yield of leaf per plot. The plants were harvested at 57, 63, 67 and 72 days from sowing. After the 63rd day, when 20-25% of the plants had bolted, there was no further increase in the yield of leaf. It should be noted that the yield trials have usually been harvested at this stage of development.

In the yield trial, Verina OJO/53 (Olson) and Toftegaard (Hansen) gave significantly higher yields than any of the other eight varieties. These two strains are indistinguishable from one another in the field and it seems probable that the names are synonyms. Four varieties were tested in observation plots and one of these, King of Denmark P52 (Ohlsens Enke), bolted later than any other strain of this variety included in the yield trial.

Celeriac and Leaf Celery

Eleven strains of celeriac were tested in a yield trial planted in spring 1957. The yield and quality of the roots differed considerably; many were hollow,

discoloured internally, and excessively fibrous. When half the trial was harvested in October, Invictus (Dippe), Alabaster (Daehnfeldt) and Praeger Kampe (Hansen) gave the best yields of good quality roots. Those of Invictus were almost spherical in shape whereas the roots of the other two varieties were irregular and more pointed at the base. By January 16th, when the remainder of the crop was harvested, nearly all the roots had been killed by frost. However, a high proportion of those of one variety, Imperator (Weibull), were undamaged. Samples of four varieties harvested and canned in October had a rather weak flavour.

In 1956 the Experimental Factory, Aberdeen, had promising results from the dehydration of leaf-celery supplied by the Institute and so four varieties of this vegetable were compared in a yield trial in 1957. Seed was sown outdoors on April 17th and the plants were left unsingled; the crop was cut three times during the summer. The variety Gewone Grove Snij (Rijk Zwaan) gave significantly higher yields than the other three varieties. Leaves of most varieties resembled those of ordinary celery but the leaves of Zwolse Krul (Rijk Zwaan) had the appearance of coarse-curled parsley, making it a suitable garden plant to grow for garnishing. Samples from each of the four varieties were sent to Aberdeen for further dehydration tests. The stems and leaves were dried together and then powdered. The dehydrated product from any of the four varieties may prove useful for flavouring. As leaf celery may be sown in the field and left unthinned, is easily grown and seems capable of giving very heavy yields, it could become a useful additional crop for the preserving industry.

Parsnip-rooted Parsley

Six varieties of this vegetable were compared. Roots of the varieties Tyk Sukker (Ostergaard) and Berliner P45 (Daehnfeldt) were smooth-skinned and had very few side roots, whereas a high proportion of those of the other varieties were fanged. The crop resembles carrots in many ways but did not yield as heavily; the roots began to lose weight rapidly through desiccation shortly after lifting. Samples canned by Messrs John Morrell & Co. Ltd. gave a canned product similar to freshly cooked roots.

Carrot

Observation plots of 52 strains of carrot were grown. The varieties Sweetcrop and Flakee gave the heaviest individual roots but their flesh was pale in colour. The strains which gave the most uniform and best coloured roots were the Nantes types, Early Nantes (Hurst) and Gold Pak (Ferry Morse); the Chantenay types, Red Cored Early Market (Hurst), Chantenay Red Cored (Ferry Morse), Chantenay Red Cored (Hurst) and New Stump Rooted (Clucas); the long Chantenay types, Supreme Half Long (Ferry Morse), Chantenay Ely Long Type (Ferry Morse) and Regulus II W:s 54 (Weibull). On the whole the colour of roots of Chantenay and long Chantenay types was better than that of Nantes types but the flavour and texture were usually inferior.

Miscellaneous Vegetables

A limited number of varieties of curly kale, ridge cucumber, orach and beetroot were grown for observation. A new type of beetroot called Butroot

Bloodred Cylinder (Daehnfeldt) was tested. The plants of this variety form "intermediate"-shaped roots which are more suitable for slicing than globe beets. They have a flesh colour as good as many strains of Detroit. Samples sent to Messrs A. Baxter and Messrs Scott for canning and pickling tests gave promising results. (C. North, L. H. Frith, H. Taylor.)

PLANT BREEDING

Brussels Sprout

During the spring of 1957, plants selected from a wide range of F_1, F_2 and triple-cross families were selfed and pair-crossed by hand pollination in the glasshouse. The flowers of two plants from one of the F_2 lines showed varying degrees of male sterility. Therefore the 522 plants of this family, which had been left in the field, were examined when they came into flower and it was found that 8% of them were, to some extent, male sterile. Ten plants which appeared to be fully self-sterile were propagated vegetatively for further examination.

Plants of 17 F_1 lines arising from crosses between the varieties Cambridge Special, Ashwells, Amager and Castricum Glory, were planted in June 1957 as a yield trial so that selection could be based on yield as well as on visual assessment. The most promising lines were those from Cambridge Special x Ashwells; they gave rather dwarf plants which produced very firm, dark-green, smooth sprouts that were less prone to rotting than those of most other stocks. Lines from Amager x Cambridge Special were very uniform; the plants were taller, but less productive than those of Cambridge Special x Ashwells. The results of the yield trial of these lines showed that their correct order of yield could not be determined by visual assessment.

Cabbage

One of the F_2 lines from Christmas Drumhead x Blåtopp tested in the field during 1956-57 was extremely uniform and gave a high proportion of good quality heads which matured in the autumn. Selected plants from this line were selfed and pair-crossed in spring 1957. Cuttings were taken from all selected plants so that, if necessary, pollinations might be repeated after the material had been tested in the field.

Twenty-nine F_2 lines from crosses between January King and Amager types were compared in a yield trial in 1957-58. Individual lines varied considerably in uniformity and heading qualities and plants for further work were selected only from the best lines. Families arising from January King x Ormskirk Savoy and subsequently back-crossed to January King were grown at the same time as the F_2 lines mentioned above. Several of them gave encouraging results and further selections were made for pollinating in spring 1958. (G. Priestley, C. North, H. Taylor.)

Beans

Fifty-two stocks derived from crosses between *Phaseolus multiflorus* Willd. var. Princeps and *P. vulgaris* L. var. Record were tested in the field. The results were disappointing, as only a few plants grew sufficiently well to justify further selection. More interspecific crosses were made using different

varieties of these two species, and French bean varieties were crossed with Tschermak Multigaris—a dwarf bean variety from Czechoslovakia said to have arisen from an interspecific cross between *Phaseolus coccineus* and *P. vulgaris*. This material will be back-crossed to *P. vulgaris* in 1958.

One hundred and twenty-seven F_3 stocks of the French bean varieties Record x Double Princess and Record x Refugee were grown outdoors. Some of the lines were very promising, especially those from Record x Refugee, which combined the earliness and good pod appearance of the former parent with the complete lack of stringiness of the latter. In view of these encouraging results the breeding programme for French beans will be expanded in 1958. (G. Priestley.)

PHYSIOLOGICAL INVESTIGATIONS

Earlier work showed that the leaf length/leaf width ratio of the tenth leaf from the base of the plant was usually smaller in early than in late maturing strains of the cabbage. Therefore an experiment was made to find if the relative rates of maturation of cabbage strains could be predicted from leaf measurements taken at an early stage of plant development. Seeds of 45 cabbage strains, chosen to cover a wide range of maturation rates, were sown outdoors on April 11th. The seedlings were transplanted in the field on June 10th. Twenty plants of each strain were sampled and the leaf length/leaf width ratio was measured for the seventh leaf, chosen because at that time it was the youngest leaf large enough to measure under field conditions. Records were made of the dates when each of the plants formed a marketable head. There was a significant correlation between the mean leaf length/leaf width ratio of a variety and the time it took to mature. However, plants of pointed-headed varieties usually had narrower leaves than those of round-headed varieties which matured at about the same time. The results suggest that it may be possible to make a preliminary selection for time of maturation when cabbage plants are lifted for transplanting. (C. North, L. H. Frith.)

PUBLICATIONS

North, C. and Frith, L. H. (1957). Variety Trials of Vegetables in Scotland. II. Stringless types of dwarf French beans: Invergowrie 1954-1956. *Rept. Scottish hort. Res. Inst.*, 1956-57, 43.

(The variety Refugee, grown exclusively in England for canning, gave poor yields during cool summers. The stringless-podded varieties Record, Saxa and Konserva II are recommended to replace Refugee in Scotland. Record gave as good yields as the popular non-stringless variety Masterpiece.)

North, C. and Frith, L. H. (1957). Variety Trials of Vegetables in Scotland. III. Brussels Sprouts: Invergowrie 1952-1957. *Rept. Scottish hort. Res. Inst.*, 1956-57, 48.

(Seventy-nine strains were examined. They were judged for yield and sprout-quality including firmness, colour, size and freedom from rotting and frosting. The small-sprouted varieties Cambridge Special and Sanda gave the best yields of high quality sprouts. Good yields were also given by The Cluseed and Evesham Special (Tozer): the sprouts of these varieties were larger but not so firm as those of Cambridge Special and Sanda.)

CROP PHYSIOLOGY

T. SWARBRICK

THE SEASONAL GROWTH OF PLANTS IN RELATION TO LIGHT INTENSITY AND TEMPERATURE

The series of pot experiments, initiated in 1956, was resumed in the spring of 1957. These experiments were made to determine the effects of seasonal changes in light intensity and temperature on the vegetative growth of the sunflower (*Helianthus annuus* var. Pole Star) and the field bean (*Vicia faba* var. *equina*). The experimental method was described in the last Report. Briefly, pots of plants of a standard morphological status were paired at the beginning of each week and one pot from each pair was harvested immediately. The remaining pot was harvested after an interval of one week. At harvest the leaf area of the plants and the dry weight of the various plant portions was determined and the net assimilation rate, (increase in dry weight per unit of leaf area, per unit of time) the relative leaf area (leaf area/plant dry weight) and the relative growth rate (increase in dry weight per unit of plant dry weight per unit of time) were calculated for each week.

Continuous records of light intensity and temperature were made in the experimental area.

In 1956 observations were made over periods of 17 weeks (June 4th-October 1st) and 16 weeks (June 15th-September 28th) for the field bean and sunflower respectively. In 1957, to include a wider range of environmental conditions, observations were made during 26 weeks (April 25th-October 24th) for the field bean and 23 weeks (May 14th-October 22nd) for the sunflower.

In general the results of the two years agree well; they showed that (i) in the field bean, in 1956, the rates of assimilation and growth were both positively linked with light intensity alone, but over the wider temperature range in 1957 the net assimilation rate and the relative growth rate were both positively dependent on temperature as well as light intensity; (ii) whereas the leaf area ratio was not significantly affected by either light or temperature in 1956, it was depressed by increasing light but increased by rising temperature in 1957; (iii) in the sunflower, in each year, the rates of assimilation and growth were both positively correlated with light intensity and temperature; (iv) the leaf area ratio was significantly decreased by increasing amounts of light in both series but only in 1957 was it increased by increases in temperature.

Experiments similar to those described were made with sunflowers at Oxford (Blackman et. al. *Ann. Bot. N.S.* 19 (76), 527, 1955) in 1950 and 1951. Since the experiments were made in different years no direct comparisons can be made but the results indicate that, whilst growth was more rapid in England during May and early June, at the period of peak growth in late June the growth rate at Mylnefield at least equalled or even exceeded the rates of growth

recorded at Oxford. However, the period of maximum growth was shorter in the north and the growth rate decreased more rapidly during July, August and September.

These series of experiments have revealed the relative effects of light and temperature on the seasonal pattern of growth at Mylnefield but owing to their design they do not allow a critical assessment of the quantitative effect of either factor alone. (G. L. Hodgson.)

THE CONTINUOUS RECORDING OF LIGHT INTENSITY

In the analysis of the environmental factors affecting plant growth in Scotland it has proved extremely difficult to find reliable instruments for the continuous measurement of light intensity. Particular difficulty has been experienced in finding instruments of the same design which agree when exposed under the same conditions.

During 1957, 12 instruments of four different designs were tested over a period of several months. Three instruments similar to the one described by Blackman, Black and Martin (*Ann. Bot. N.S.* 17 (68), 529, 1953) were accurately calibrated at the National Institute of Agricultural Engineering, Silsoe, before being tested at Mylnefield. The results showed that under identical conditions agreement was poor, especially in bright sunlight.

Four photo-electric integrators developed at the National Institute of Agricultural Engineering, Silsoe, (Trickett and Moulsley, *J. agric. eng. Res.* 1, 1, 1956) were compared over four months. The values from each instrument agreed within ± 2% except on occasions when moisture affected the photo-electric head. This fault has been overcome in a commercial version and this instrument, when fully developed should prove useful in determining daily values of light intensity in biological work.

Towards the end of the season four "Megatron" photo-electric integrators were tested. This instrument was developed by Messrs Megatron Ltd. in co-operation with the National Institute of Agricultural Engineering, Silsoe, and is an improved version of the photo-electric integrator described above. These instruments were under observation only for a short period and it is not possible to draw definite conclusions on their performance.

One Robitzsch Actinometer, Mk. III, on loan from the Meteorological Office, was in use throughout the four months. This instrument proved to be most accurate, reliable and robust, and because the values are continuously recorded on a chart it is useful in the determination of day length. (G. L. Hodgson, J. Cathro.)

THE PHYSIOLOGY OF GROWTH OF THE STRAWBERRY PLANT

Effect of Photoperiod

Earlier experiments showed that vegetative growth was stimulated and flower initiation delayed in strawberry plants given short photoperiods (receptor plants) when they were connected by stolons to other plants given long photoperiods (donor plants). It has now been found that these effects are induced by donor plants given short photoperiods when the dark period is interrupted by a light break. This result suggests that the stimulus is a formative rather than a nutritive one.

Experiments have shown that the stimulus moves more readily from parent to daughter plant although movement in the reverse direction can be induced. The degree of response of receptor plants was greater when the daily exposure to sunlight was three hours longer for the donors than the receptors but this additional illumination was ineffective unless there was a light break during the night. It is thought that this enhanced response results from increased translocation from donor to receptor.

Radioactive isotopes may be useful in this context. Experiments with P^{32} have already shown that movement from donor to receptor plants is promoted by environmental conditions which promote the movement of the vegetative stimulus.

When individual strawberry plants were given a series of short days interrupted by a single long day, they initiated flowers two to three days later than comparable plants given only short days, suggesting that the single long day had an inhibitory effect on flower formation. This technique gives results more quickly than experiments with donor and receptor plants joined by stolons but unfortunately either method can be used only when the plants are in a suitable condition.

All these results suggest the existence in the strawberry of a regulatory system which inhibits flower initiation but stimulates vegetative growth. (C. G. Guttridge.)

Effect of Leaf Maturity on Flowering

When strawberry plants are defoliated in the field after flowering they appear to initiate flowers more freely during late summer and autumn than those left intact. In autumn 1956 a small experiment was set up to study the influence of leaf age on flower initiation. Talisman plants, from which each leaf was removed as it became fully expanded, initiated flowers sooner than those left untreated. Flower initiation was delayed in plants allowed to retain their three oldest leaves but from which all young leaves were removed before they unfolded.

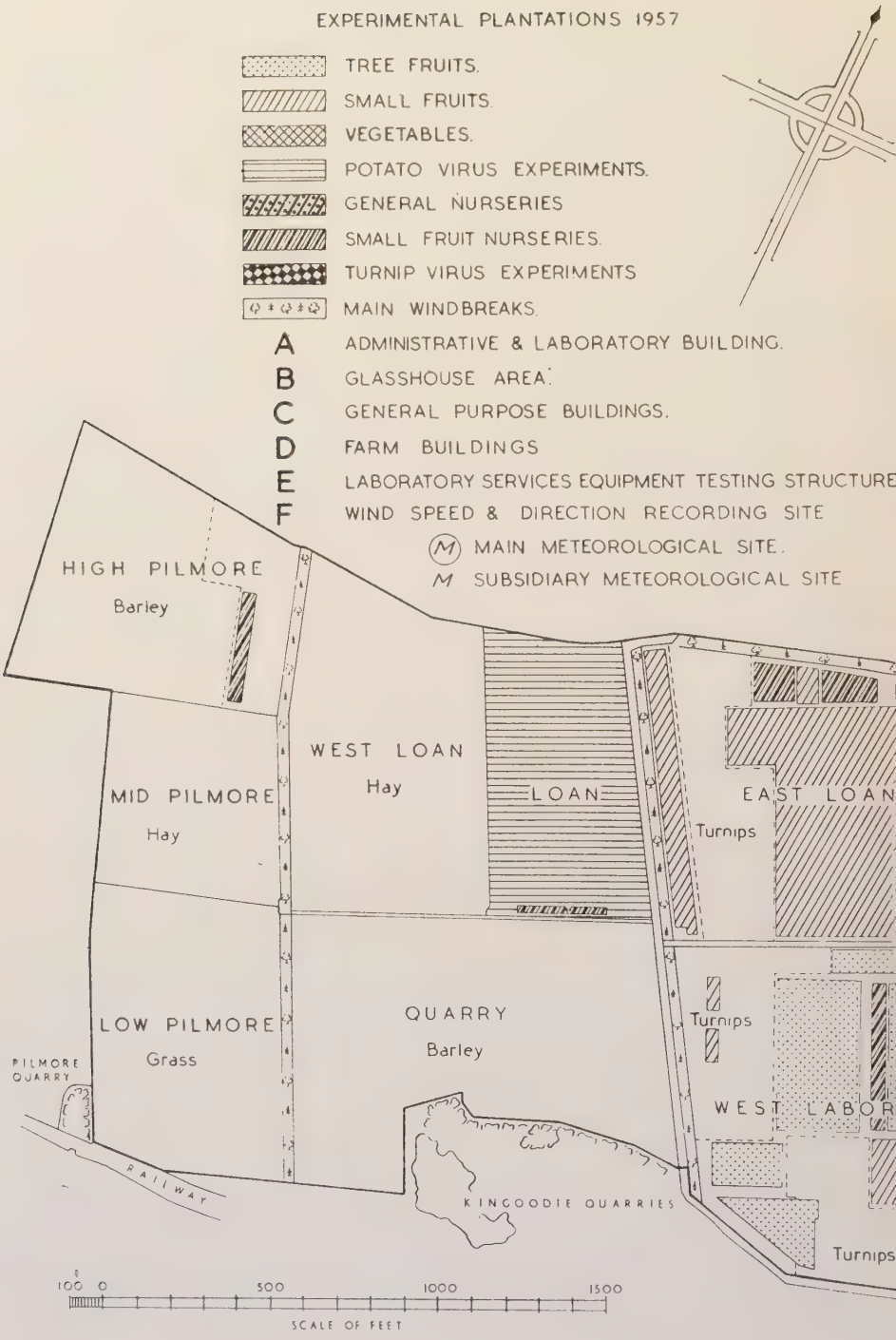
This experiment was repeated in 1957 and included a treatment in which two of the three leaflets of each emerging leaf were removed before they unfolded while the old leaves were left intact. In plants so treated flower initiation was delayed, but for a shorter time than in plants from which all the young leaves had been entirely removed. Differences in leaf area between treatments did not provide a satisfactory explanation of this result, and it seems that not only did the young leaves promote flower initiation but that the old leaves actually had an inhibitory effect.

Some of the plants initiated flowers in summer, a feature of Talisman, but these formed a normal complement of flower buds in autumn, a result which agrees with earlier observations on other varieties. (P. A. Thompson.)

Investigations into the effects of autumn cloching and post-harvest defoliation on flower initiation and subsequent cropping were continued. (C. G. Guttridge.)

Effects of Growth Substances

During the late summer of 1956 a pilot experiment was conducted to investigate the effect of various promoters and inhibitors on strawberry plants



SCOTTISH HORTICULTU
MYLNEFIELD
INVE

AREAS OF FIELDS

STRIP	10 ¼ ACRES
MID NORTH	13 ½ "
LADE	8 "
HAUGH	4 "
MILL	3 "
BULLION SOUTH	40 ½ "
SCHOOL	22 ½ "
BUNGALOW	15 ¼ "
LABORATORY	8 "
WEST LABORATORY	22 "
EAST LOAN	18 ¼ "
LOAN	8 ½ "
WEST LOAN	12 ¾ "
QUARRY	17 ¾ "
HIGH PILMORE	11 ½ "
MID PILMORE	7 "
LOW PILMORE	10 ¾ "

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ST ANDREW'S HOUSE, EDINBURGH 1

in the field with particular reference to autumn flower initiation. The substances chosen were: the triethanolamine salt of maleic hydrazide (MH), used at a concentration equivalent to 250 ppm of MH in water and applied as a dip to the youngest leaves only; and 3-indolyl acetic (IAA), triiodobenzoic and naphthylacetic acids, each of which was applied at 100 ppm in lanolin to the base of the leaflets of the youngest leaves. All treatments were repeated at weekly intervals during July and August. From the time of the first application of MH, runner development was almost completely suppressed.

Records made in 1957 showed that treatment with MH or IAA significantly increased the total yield of fruit but not the weight of fruit per inflorescence nor the number of inflorescences per crown. Since both treatments increased the number of branch crowns, MH significantly so, it seems likely that the increase in crop weight resulted from the increase in crowns available as sites for flower initiation in the previous autumn. Later work with MH has confirmed its effectiveness as a means of increasing branch crowns in the autumn. A further experiment in 1957 confirmed that MH effectively prevented root development and leaf emergence in young runners but did not decrease the number of runners initiated.

Dissections in November of the crowns of plants treated with MH, suggested that MH had also interfered with the development of inflorescences. For this reason MH was applied to plants of Climax in the greenhouse at a time when flower initiation was known to be proceeding. When applied at 250 ppm as a dip to the youngest leaf, at four-day intervals, flower initiation was completely inhibited although there was no change in the rate of leaf initiation. The result was similar when MH was applied as a spray to the whole plant at 125 ppm. Flowers initiated just before the start of treatment failed to develop normally. Development ceased very soon after the first application of MH irrespective of the particular stage of differentiation reached. The first symptoms of malformation occurred in the carpels. Where the ovules had failed to develop living embryos, the receptacles swelled and ripened although unfertilised. This effect was especially striking when normal and malformed ovules occurred on the same receptacle; those parts of the receptacle carrying malformed ovules swelled and ripened whereas those carrying normal but unfertilised ovules did not. This result suggests that, unless fertilised, living embryos inhibit swelling of the receptacle in their immediate vicinity. (P. A. Thompson.)

Cold-Storage of Strawberry Runners

Plots planted on June 22nd, 1956, with cold-stored runners of Redgauntlet yielded over 15 oz. per plant in 1957, and treated plants of Talisman only a little less. These results are encouraging and a new experiment was planted in 1957. Redgauntlet plants survived well when stored in polythene-lined wooden boxes at 28-30°F from February until they were planted in July. Comparable plantings of freshly lifted runner plants were made in July and at intervals subsequently. (C. G. Guttridge.)

PUBLICATIONS

GUTTRIDGE, C. G. (1958). The effects of winter chilling on the subsequent growth and development of the cultivated strawberry plant. *J. hort. Sci.*, **33**, 119.

(Exposing strawberry plants to low temperature in winter affects their subsequent response to environmental conditions. Plants given an 11 hr. photoperiod at 60-62°F in a growth room in November continued to initiate flowers; the dry weights of roots and crowns increased although the plants produced no stolons and leaves that were small and had short petioles. By contrast, comparable plants, chilled before exposure to similar controlled conditions, grew vigorously, produced many runners and large leaves with long petioles but failed to initiate flowers for several weeks. Reduction of the carbohydrate level of plants, by shading in autumn or exposure to low light intensity in spring, had a small effect on the degree of response to cold treatment.)

GUTTRIDGE, C. G. (1957). Growth rooms constructed from butchers' cold rooms, *Control of the Plant Environment*. Edited by J. P. Hudson, London: Butterworths Scientific Publications.

GUTTRIDGE, C. G. (1957). Paired growth cabinets. *Control of the Plant Environment*. Edited by J. P. Hudson, London: Butterworths Scientific Publications.

(Brief descriptions are given of the growth rooms and cabinets at Mylnefield used for physiological work with the strawberry plant.)

GENETICS

T. Swarbrick

SPRING CHLOROSIS OF STRAWBERRY

June Yellows is the most important kind of variegation in the strawberry but by no means the only chlorotic disorder to which the strawberry is prone, as became clear when the behaviour of seedlings raised from selfs and crosses of commercial strawberry varieties was studied in the field. Observations were made on the 163 progenies planted in 1956 and on a further 58 progenies raised from crosses made in 1956 and planted in 1957. They suggest that there are two principal kinds of abnormal behaviour. Plants either produce variegated leaves throughout the year, the variegation consisting of large yellow sectors which gradually become white, or they produce abnormally coloured leaves in spring and autumn but normal ones in summer. The second group comprises two categories: plants which produce leaves with green and yellow mottling and occasional white streaks, symptoms typical of June Yellows in Auchincruive Climax for example; and plants which produce leaves that are initially pale yellow but in which normal green pigmentation gradually spreads outwards from the midrib, the margins sometimes changing colour from yellow to white before the leaves become completely green.

Although these abnormalities are clearly heritable their mode of inheritance is obscure. The results of reciprocal crosses between Auchincruive Climax and several other varieties show that the factors causing June Yellows are transmitted mainly through the egg cell and only rarely through the pollen. When Tardive de Leopold was pollinated by Auchincruive Climax however, more than 40% of the resulting seedlings were chlorotic, although no abnormal seedlings occurred in crosses where Tardive de Leopold was pollinated by varieties other than Auchincruive Climax.

Since the cultivated strawberry is an octoploid ($2n=56$) and is of hybrid origin, attempts are being made to simplify the genetics of June Yellows by breeding strawberry plants with this character but possessing fewer chromosomes. Hexaploid ($2n=42$) seedlings, some of which show June Yellows, were obtained from a cross between Climax and autotetraploid ($2n=28$) *Fragaria vesca*, but attempts to cross these seedlings with diploid ($2n=14$) species have not yet succeeded.

MISCELLANEOUS

Sone of the plants of brussels sprout and cabbage grown from seed exposed to gamma rays and neutrons died prematurely and others grew slowly but most showed no gross effects of irradiation.

Crosses were made in all possible combinations between the black currant varieties Amos Black, Brödtorp and Baldwin with the red currant varieties Minnesota, Red Lake and Laxton's No. 1. Seedlings of the only family yet germinated, Minnesota x Brödtorp, have hairs and external glands intermediate in size and shape between those of the parents. They have not yet flowered. (A. B. Wills.)

VIROLOGY

C. H. Cadman

VIRUSES AND TANNINS

Experiments with tannic acid and an unidentified polyphenolic tannin present in raspberry leaves provided new evidence of the nature of the reaction between viruses and tannins. When mixed in the inoculum, both tannic acid and the raspberry tannin inhibit infection of plants by viruses, but the degree to which they do so depends on the virus and not the host plant. Both kinds of tannin combine irreversibly with some viruses but with others the combination is readily reversed by dilution or increase in pH.

The results of experiments with mixtures of viruses and tannins *in vitro* suggested ways of modifying techniques for mechanical transmission of viruses from tannin-containing plants which include raspberry, strawberry and tree-fruit plants such as cherry and plum. The infectivity of extracts made from raspberry leaves containing raspberry ring spot or beet ring spot viruses varied with the concentration of tannin present and the pH. Extracts made with 2·5% nicotine base contained less tannin and were usually more infective than those made with the aid of alumina or buffer solutions at pH 8. Both viruses were precipitated by acetone or ammonium sulphate from extracts made from infected raspberry leaves with the aid of nicotine or alumina and tomato black ring virus was detected serologically in preparations made from infected raspberry leaves.

Peach and apple leaf extracts seem to contain much less tannin than those from raspberry, strawberry, cherry or plum. The beet ring spot strain of tomato black ring virus was readily transmitted by mechanical inoculation of infective sap from tobacco to peach and from peach to tobacco but not from tobacco to raspberry. (C. H. Cadman.)

SOILBORNE VIRUSES

Three viruses, raspberry ring spot, raspberry yellow dwarf and beet ring spot, that cause symptoms of the ring spot type in tobacco plants, were previously distinguished by the symptoms they caused in various herbaceous plants and by plant-protection tests. Tests with antisera to each of the viruses confirmed that they are not related strains for they had no antigens in common. These three viruses, however, have similar properties *in vitro* and a wide natural host range including several weed species; they are soilborne and of local importance. This behaviour may well be characteristic of viruses that cause ring spot symptoms in tobacco plants, of which many others have been described by other workers. Investigations were continued on the mode of transmission of these viruses through the soil.

Raspberry Ring Spot Virus

This virus was isolated from plants of the strawberry varieties Cambridge Vigour, Huxley and Talisman which were stunted and showed crinkle-like symptoms on their leaves. The distribution of infected plants suggested that

the virus is present in the soil in many fields in both eastern and western Scotland.

The virus, already well known in eastern Scotland in raspberry, was also found infecting raspberry in Wiltshire but the Wiltshire strain differs somewhat from the Scottish strains.

Raspberry Yellow Dwarf Virus

Plants of raspberry, strawberry and weed species in several parts of England were found infected with raspberry yellow dwarf virus. The soils at such places were medium or heavy clay-loams.

The virus was also found infecting Talisman strawberry growing in heavy soil in one locality in Lanarkshire and evidence was obtained that the virus occurs in the soil there. Almost one-third of the plants of an English certified stock of Cambridge Favourite strawberry, planted in two different localities in eastern Scotland, were found to be infected with raspberry yellow dwarf virus. The plants were probably infected, although apparently healthy, when planted, for there was no evidence that the virus was present in the soil at either locality.

Beet Ring Spot Virus

Beet ring spot virus, not previously found in raspberry, was isolated from plants of Malling Expoit, Malling Seedling K and Malling Seedling V, three varieties not tested before, and also from stunted plants of Talisman strawberry. The woody plants, peach and cherry also became infected with this virus when grown in virus-infested soil. Beet ring spot virus was found to be serologically related to tomato black ring and potato bouquet viruses, which occur in Scotland, England and Germany, respectively. The Scottish virus is more closely related to the English than to the German one, and the German virus is more closely related to the English than to the Scottish virus. Thus the degree of difference between these three related viruses seems to reflect their geographical separation, a pattern of variation which may well be typical of soilborne viruses.

Ring-Necrosis Viruses

Viruses resembling and possibly related to potato stem-mottle virus were isolated from and shown to be soilborne to potato, oat, sugar beet and turnip. Studies on their properties and relationships were continued. (C. H. Cadman, B. D. Harrison, R. M. Lister.)

APHID-BORNE VIRUSES IN RASPBERRY AND STRAWBERRY

Cucumber Mosaic Virus in Raspberry

A strain of this virus was isolated from naturally infected Lloyd George raspberry plants. The aphid *Amphorophora rubi* transmitted it from *Datura stramonium* to black raspberry (*Rubus occidentalis*) plants. (B. D. Harrison.)

Virus-Free Raspberry Stocks

The graft-tested stocks of Lloyd George, Malling Exploit, Malling Jewel, Malling Promise and Norfolk Giant raspberry, which were of known low virus content, have now been superseded by virus-free stocks of these varieites

propagated from heat-treated plants. Annual distributions of this material are planned.

Virus-free mother plants of the above and other commercially important varieties, grown in sterilized soil and kept under insect-free conditions, now provide roots from which crops of young plants are propagated annually under glass in early spring. By this means, several hundred canes can be propagated in one year from a single mother plant. These young plants are transplanted to the field in late April to early May, and used to establish a cane nursery from which canes are harvested in autumn of the following year. This technique effectively decreases the time for which virus-free plants are exposed to infection by aphid-borne viruses before they are distributed to growers.

Plants raised by this method in 1956 suffered badly from wind damage in late summer but in spring 1957 cane nurseries of Lloyd George, Malling Exploit, Malling Jewel, Malling Promise and Norfolk Giant were successfully established. (J. Chambers.)

Spread of Viruses in Strawberry

The results of field and glasshouse tests show that neither Talisman nor Redgauntlet strawberry should be planted near to diseased stocks of virus-tolerant varieties such as Cambridge Favourite. Plants of both varieties, particularly Talisman, become severely stunted when infected with the viruses that cause the yellow-edge and crinkle diseases in Royal Sovereign. The preliminary results of a field experiment, begun in 1957, suggest, however, that neither Talisman nor Redgauntlet is more susceptible to infection by these viruses than is Royal Sovereign.

The results so far obtained from exposing successive batches of runnerless *Fragaria vesca* plants to infection by viruses spreading from diseased Cambridge Favourite plants show that more spread of aphid-borne viruses occurred in early October than in July or August; this despite the fact that aphids transmitted viruses efficiently from the Cambridge Favourite plants throughout the season. (R. M. Lister.)

APHID-BORNE VIRUSES IN POTATO

Potato Leaf Roll Virus

Experiments on the transmission of potato leaf roll virus from infected to healthy *Physalis floridana* plants by *Myzus persicae* again showed that there is a delay in development of infectivity of aphids that have fed for less than 24 hr. on infected plants. Tests with single aphids given acquisition feeds of 4, 8 or 16 hr. on diseased plants and then transferred daily, until they died, to fresh healthy plants, showed that both persistence of infectivity and the frequency of transmission by infective insects varied directly with the length of the acquisition feed. (C. H. Cadman.)

Virus strains which caused mild or severe symptoms in *P. floridana* plants differed in the ease with which they were transmitted by *M. persicae*. Plants already infected with the avirulent strain did not develop additional symptoms after being infested with aphids carrying the virulent strain. Aphids, which had acquired and transmitted the avirulent strain, were able to acquire and transmit the virulent strain (B. D. Harrison.)

Field Spread of Y and Leaf Roll Viruses

In contrast to 1955, little spread of either virus occurred in the experimental crops at Mylnefield and the results obtained were inconclusive. However, leaf roll spread more in plots planted in mid-May than in those planted earlier and as much in plots rogued in early July as in those not rogued.

Thirty-six field crops were sampled in 1956; 2 in Midlothian, 5 in Fife, 3 in the coastal districts of Angus and 26 in the inland parts of Angus and Perthshire. The samples were grown on in 1957 and these showed that spread of leaf roll had occurred in 20 out of the 36 crops. The 16 crops in which no spread of virus was detected were all grown in inland districts of Angus and Perthshire. Those in which virus spread most were grown in Midlothian, and the coastal districts of Fife and Angus. (J. Chambers.)

Potato Aphids

The 1957 season was an unusual one in many respects. The mild winter favoured overwintering aphids; warm weather in early spring hastened their multiplication and dispersal and there were signs that infestation of potato and other crops by *Myzus persicae* was likely to be unusually early and heavy. In mid-April, counts of 25-120 *M. persicae* per plant were recorded in crops of spring- and seed-cabbage respectively, in Midlothian. Winged *M. persicae* were caught on June 14th and 16th in water traps exposed in potato crops in three different sites in Angus and by the end of the month these crops had populations of 5-10 *M. persicae* per plant. In contrast to the three preceding seasons, aphid populations decreased rapidly after mid-July and by mid-September no *M. persicae* was found at any of the three sites.

Primary leaf roll symptoms were seen in many potato crops and virus yellows appeared early and spread rapidly in sugar beet crops in coastal districts of Fife and Angus. These observations support the idea that the low rates of spread of viruses transmitted by *M. persicae* usually observed in potato and other crops in eastern Scotland are associated with the lateness (mid-July to early August) of arrival of alate aphids.

In September, 1956, crops of spring- and seed-cabbage at Musselburgh were sprayed with Parathion or Metasystox to find whether these treatments would effectively decrease the overwintering populations of *M. persicae*. The treated plants became recolonised within a month and, although they carried fewer aphids throughout the winter, by mid-June, populations on the sprayed plants were as large as on those unsprayed. (A. G. Fisken.)

VIRUSES TRANSMITTED BY FLEA BEETLES

Three viruses transmitted by flea beetles are widespread in turnip and swede crops in eastern Scotland; they are turnip yellow mosaic, turnip crinkle and turnip rosette viruses. The first two of these occur without symptoms in swede, but respectively cause severe chlorosis and leaf crinkling in yellow turnip. Swedes and turnips infected with turnip rosette virus are usually stunted and have necrotic patches on their leaves. The effects of infection on leaf growth and symptoms are much more severe when, as is common, plants are infected with more than one of the viruses.

The root yield of healthy yellow turnips (var. The Bruce) was compared, in a field trial, with that from plants artificially infected with local strains of each of the three viruses, singly and in all possible combinations. Rather surprisingly, there was no significant difference in yield between healthy and infected plants despite the drastic effects on the foliage caused by some combinations of viruses. (R. M. Lister.)

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General Papers

Cadman, C. H. (1958). A ring-necrosis virus of potato. *Proc. 3rd Conf. on Potato Virus Diseases, Wageningen*, 1957. (In press.)

Cadman, C. H. (1958). Modes of spread and the control of viruses in soft-fruit crops. *Sci. Hort.* 13. (In press.)

Cadman, C. H., Harrison, B. D. and Lister, R. M. (1958). And now—soilborne viruses. *Commercial Grower*, 14th February, 1958.

Harrison, B. D. (1958). Beet ring spot—a soilborne virus infecting potatoes in Scotland. *Proc. 3rd Conf. on Potato Virus Diseases, Wageningen*, 1957. (In press.)

Lister, R. M. (and Thresh, J. M.) (1958). The history and control of cocoa swollen shoot disease in Nigeria. *Rept. Cocoa Conf., London*, 1957, 132.

Research Papers

Cadman, C. H. and Fisken, A. G. (1958). Susceptibility of raspberry varieties to infection by aphid-borne viruses. *J. hort. Sci.*, **33**, 000

(Field and glasshouse experiments with two raspberry viruses transmitted by *Amphorophora rubi* showed that raspberry varieties differed greatly in the frequency with which plants became infected. Of the varieties tested, Norfolk Giant seemed the most resistant and Lloyd George and Malling Jewel the most susceptible but raspberry plants are relatively resistant to infection and both viruses spread only slowly even in Lloyd George. Spraying plants of this variety with Systox decreased the population of *A. rubi* more than by spraying with DDT emulsion or Parathion; spraying with Systox also appeared to decrease the spread of veinbanding virus.)

Harrison, B. D. (1957). Studies on the host range, properties and mode of transmission of beet ring spot virus. *Ann. appl. Biol.*, **45**, 462.

(A sap-transmissible virus, named beet ring spot, was found infecting many kinds of crop and weed plants in several localities in eastern Scotland. The symptoms produced in *Chenopodium amaranticolor*, French bean, tobacco and *Petunia hybrida* plants and its behaviour in plant-protection and serological tests distinguish the virus from raspberry ring spot, tobacco ring spot, potato bouquet and tobacco rattle viruses.

Plants of sugar beet, beetroot, potato, turnip, swede, French bean, *Fragaria vesca*, oat and wheat became infected with the virus, often systemically, when grown under glass in soil from a site where the disease occurred, showing that beet ring spot virus is soilborne. When sugar beet seedlings were grown in virus-containing soil, the virus was first detected in their roots, where its concentration increased, before progressively increasing amounts of virus were found in the shoots.

Beet ring spot virus has been found only in light, sandy soils and often in fields where raspberry ring spot virus occurs.)

Harrison, B. D. (1957). Soil transmission of beet ring spot virus to peach (*Prunus persica*). *Nature, Lond.*, **180**, 1055.

(Peach seedlings developed symptoms resembling those of peach yellow bud mosaic, after planting in soil containing beet ring spot virus. Viruses, afterwards identified as beet ring spot virus by plant-protection and by serological tests, were readily isolated from each diseased tree by mechanical inoculation of leaf extracts to *Chenopodium amaranticolor*, *Petunia hybrida* and cucumber plants. The virus was isolated only from

leaves with symptoms and was not detected in the plants that did not show symptoms or in control plants grown for the same period in steam-sterilized potting compost.)

HARRISON, B. D. (1958). Relationship between beet ring spot, potato bouquet and tomato black ring viruses. *J. gen. Microbiol.* **18**, 450.

(Beet ring spot virus was considered distinct from potato bouquet, a virus isolated from potato in Germany, because tobacco plants infected with the first of these were not immune from infection by the second and because an antiserum to beet ring spot precipitated this virus but not potato bouquet virus. However, further experiments showed that tobacco plants infected with potato bouquet virus were immune from beet ring spot virus and evidence from serological and plant-protection experiments showed that both viruses are strains of tomato black ring, a virus isolated from tomato and lettuce in England. Tomato black ring and potato bouquet viruses are more closely related to each other than either is to beet ring spot and the degree of difference between them seems to reflect their geographical separation, a pattern of variation that may well be typical of soilborne viruses. Comparison of the results of serological and plant-protection tests suggests that they may measure different properties of the virus particles.)

HARRISON, B. D. (1958). Cucumber mosaic virus in raspberry. *Plant Pathology*. (In press.)

(In two Perthshire plantations of Lloyd George raspberry, plants were found that had blotching symptoms on their leaves and that contained a sap-transmissible virus. Plant protection tests in *Petunia hybrida* and tobacco showed that the virus was a strain of cucumber mosaic virus. It was transmitted from infected *P. hybrida*, cucumber and sugar-beet to *Datura stramonium* and tobacco by *Myzus persicae* and from infected *D. stramonium* to black raspberry, (*Rubus occidentalis*) by *Amphorophora rubi* but not by *M. persicae* or *Macrosiphum euphorbiae*. Attempts to transmit the virus from Lloyd George raspberry to *D. stramonium* using *A. rubi* and *M. persicae* failed and it seems likely that cucumber mosaic virus is only rarely transmitted from raspberry to raspberry in the field.)

HARRISON B. D. (1958). Raspberry yellow dwarf, a soilborne virus. *Ann. appl. Biol.* **46**, 221.

(A sap-transmissible virus, provisionally named raspberry yellow dwarf, was isolated from naturally infected raspberry, strawberry, blackberry and several weed species by mechanical inoculation of sap to *Chenopodium amaranticolor*. It causes a severe disease in Malling Exploit raspberry and in strawberry and seems widely disseminated in England but to be recently introduced and rare in eastern Scotland. The results of plant-protection and serological tests gave no evidence that the virus is related to raspberry ring spot, tobacco ring spot, tomato black ring or cucumber mosaic viruses. Raspberry and sugar-beet plants became systemically infected with the virus when grown under glass in soil from a field where the disease had occurred in raspberry plants, and where the virus persisted in the soil for three years after the raspberry plants were removed. Like other viruses which cause symptoms of the ring spot type in tobacco, raspberry yellow dwarf virus has a wide natural and experimental host range, is soilborne and of local importance.)

HARRISON, B. D. (1958). Studies on the behaviour of potato leaf roll and other viruses in the body of their aphid vector *Myzus persicae* Sulz. *Virology*. (In press.)

(By means of a simple technique, which is described, peach-potato aphids (*Myzus persicae*) were made infective by injecting them with extracts from aphids that had fed on plants infected with potato leaf roll or beet yellow net viruses. In optimal conditions, half the injected aphids transmitted potato leaf roll virus but many fewer transmitted beet yellow net virus and attempts to make aphids infective with beet yellows virus were unsuccessful.

This injection technique was used in experiments to detect whether potato leaf roll virus multiples in *M. persicae*. The results suggest that the amount of potato leaf roll virus acquired by aphids increases with increasing feeding period on diseased plants,

that the virus passes through the blood of the insects and is then trnasmitted back to plants, and that it does not multiply in the aphid.)

HARRISON, B. D. (1958). Ability of single aphids to transmit both avirulent and virulent strains of potato leaf roll virus. *Virology*. (In press.)

(Experiments with two strains of potato leaf roll virus and peach-potato aphids (*Myzus persicae*) provided evidence that this virus does not behave like aster yellows virus, which multiplies in its insect vector. *Physalis floridana* plants infected with an avirulent strain seemed immune from subsequent infection by a virulent strain of the virus but single *M. persicae*, which had transmitted the avirulent strain to healthy plants, subsequently acquired and transmitted the virulent strain apparently as readily as did previously virus-free aphids. Both virus strains were recovered from some of the plants infected by means of single aphids carrying both strains. The insect transmission of potato leaf roll resembles that of beet curly top, a virus which seems not to multiply in its insect vector, and differs from that of aster yellows, a virus which multiplies in its vector.)

MYCOLOGY

A. R. Wilson

GREY MOULD OF SOFT FRUIT

Autecology of Botrytis cinerea

The results from the Hirst spore trap, sited in a raspberry plantation at Mylnefield, showed that the concentration of airborne spores was often related to macroclimatic factors. In a fruit season during which there was little grey mould or mildew (*Sphaerotheca humuli*), most spores of *B. cinerea* were usually trapped at midday, when the relative humidity was within the range 85-65% and falling rapidly. Smaller increases in spore concentration occurred when the humidity was rising, for example at the end of dry sunny days. The peak concentrations at midday were of the order of 600-1000 spores/cu. m. At night, there were usually long periods when few spores were trapped but the numbers increased during heavy rainstorms accompanied by high winds.

Temperature was a limiting factor in spore dispersal throughout the season. When night temperatures remained below about 13°C for long periods, few spores were trapped in the morning despite favourable conditions of falling humidity and rising temperature, perhaps because low night temperature decreased the rate of sporulation. This is being investigated in controlled environments.

The seasonal pattern of spore dispersal seemed to be related to the ripeness of the fruit. Before picking started, spore concentrations remained steady in the range 5-20/cu. m.; as the fruit ripened they rose rapidly, showing considerable fluctuation, and finally fell as the crop was removed.

The effect of the ripeness of strawberries on spore germination has been examined. Under humid conditions, only 1% of dry spores germinated on green fruit in 24 hr. as compared with 63% on ripe fruit. Under the same conditions, spores applied as a suspension in water germinated more rapidly, 74% and 91% in 4 hr. on green and ripe fruit respectively.

Over 60% of isolations from petals, fragments of straw and other organic debris adhering to strawberry fruit yielded *B. cinerea* but in a small experiment only 11% of the fruit was infected in strawed plots as against 16% in unstrawed plots.

During the spring and early summer, sclerotia of *B. cinerea* were found in strawberry plantations on 50% of wheat straws remaining from the 1956 season, on 70% of dead fruiting-stalks and fruit, and on 35% of dead petioles and stolons. All sclerotia tested during the spring and summer were viable. Thus, for reasons of hygiene, the practice of burning or mowing and removing straw and plant debris after the fruit season is to be recommended.

Viable sclerotia were found on about 1% of the canes in raspberry plantations but rarely on the small amount of plant debris remaining on the surface of the soil after cultivations.

Control

Griseofulvin 3% dust* applied at 21 lb./acre and griseofulvin oxime 5% spray concentrate* applied at 140 and 280 gm. in 30 gal. water/acre were compared with standard Captan treatments in pilot trials on three varieties of strawberry and one variety of raspberry. Although less fruit was infected in both crops on plots treated with griseofulvin dust and Captan dust than on the untreated plots, these differences were not significant even at the 10% level because of lack of refinement in the layout of the trials. The highest level of infection (18·2%) in untreated plots of strawberries was recorded on Talisman, which is generally regarded as very susceptible to the disease. The figures for the other two varieties, Climax and Redgauntlet, were 12·4% and 6·3% respectively. The raspberry variety, Malling Promise, showed 1·6% infection. (W. R. Jarvis.)

GREY MOULD OF TOMATOES

A preliminary survey of the problem has been made with particular reference to conditions prevailing in glasshouses in the Clyde Valley area. Experimental work has been started. (A. R. Wilson.)

POWDERY MILDEW OF SOFT FRUIT

Little powdery mildew occurred in 1957, and catches of spores of *Sphaerotheca humuli* in the Hirst trap were very small. Occasionally up to 10 spores/cu. m. were recorded, but such concentrations did not seem related to any particular macroclimatic conditions. (W. R. Jarvis.)

STRAWBERRY RED CORE

Work was continued on the polyphenol metabolism of three races of *Phytophthora fragariae*. All were found to utilise caffeic, chlorogenic, protocatechuic and gallic acids, dl-tyrosine, d-catechin and pyrocatechol at concentrations of the order of 0·001 M but cinammic and m-digallic acids and p-cresol inhibited growth. There were marked differences between growth rates of the three races on most of the polyphenol substrates used. In no case was there any detectable polyphenol oxidase activity in cell-free culture-filtrates. Differences found between the races in intracellular activity were not associated with the differences in growth rate. Polyphenols have been extracted from strawberry roots for investigation of interactions of host and parasite enzyme systems *in vitro*.

To obtain host-parasite combinations in controlled environments, attempts have been made to culture excised strawberry roots. Many media, all of which were excellent for the growth of tomato roots, failed to support strawberry root-growth for more than a few days, even when frequently replaced by fresh medium. A modification of the Raggio method has proved the most successful. In this, part of the shoot of a seedling is placed on sucrose agar, while the root is placed on an adjacent but separate Heller's inorganic-vitamin agar. Excised roots may be readily infected by zoospores from agar cultures of the parasite. (W. R. Jarvis.)

* Supplied by Glaxo Laboratories, Ltd.

MISCELLANEOUS

A preliminary investigation was made of a brown soft-rot of the folded leaves of brussels sprout. Isolations indicated that *Botrytis cinerea* and one or more species of soft-rotting bacteria, alone or in combination, were usually present. A survey of observation plots showed that there were considerable differences between cultivars in susceptibility to the brown rot.

The Section again participated in the potato blight observation project of the Edinburgh and East of Scotland College of Agriculture. (A. R. Wilson, W. R. Jarvis.)

WEST OF SCOTLAND UNIT (AUCHINCRUIVE)

R. D. Reid

STRAWBERRY BREEDING

Work on the breeding and selection of strawberry seedlings for resistance to red core (*Phytophthora fragariae* Hickman) was continued and followed the pattern described in previous Reports. The damage caused by late spring frost, the worst experienced for 12 years, seriously hampered field work this year. On May 6th 9° of frost were recorded; a time when most of the plants were just coming into flower. It was impossible to assess the fruiting merit of many seedlings and much material which would normally have been discarded has had to be retained.

Progress with material bred during the period 1945 to 1954 was reviewed in the last Report and there have been few major developments since then. On the basis of their performance at both Mylnefield and Auchincruive, none of the selections from crosses made in 1948 and 1949 seemed worth retaining but ten of the 136 from crosses made in 1950 and 1951 were selected for further trial. Many of the 225 seedlings selected from material bred in 1952 seem promising but frost damage prevented any reliable assessment of their cropping. A large proportion has therefore been kept for further observation: 20 were selected for fruiting trials and seven of these are to be cropped under cloches. The results of graft tests show that a proportion, rather more than usual, of the 1952 selections have become virus-infected, doubtless as a result of the congested conditions under which much of this material was grown in 1953 and 1954. Attempts to free plants from viruses by heat treatment were made with equipment acquired during the year and these are being repeated. Several seedlings from crosses made in 1953 were retained for breeding purposes. All the 1400 single-plant selections from the 1954 material were severely frosted and are being grown on for a further year.

In 1957, 57 crosses and 12 selfings were made. More seeds and plants of *Fragaria* species and hybrids were received from America during the year. (R. D. Reid, A. M. Sutherland, K. C. McConnell.)

Resistance to Red Core

The 3684 selections from the seedlings from the 1955 crosses referred to last year are still being tested in the field for resistance to red core. Table 1 summarises the results obtained with material bred in 1956.

The proportion of seedlings that became infected in the bench tests varied from 2% to 50% in different families. The average, 15%, seems rather low and more of the apparently resistant seedlings are expected to break down under field conditions. Means of increasing the efficiency of the bench test are being sought. Laboratory tests are more searching and plants which seem to become infected only through their fine lateral roots may well resist

TABLE 1. Results of testing seedlings raised from 1956 crosses.

Method of testing for red core susceptibility	Totals	Discarded for red core infection	Not infected after first test	Discarded for variegation	Dead various causes
Bench tested in glass-house...	9438	1393	6807	7	1231
Zoospore suspension dip; pure cultures ...	979	770	209	—	—
Totals ...	10417	2163	7016	7	1231

infection in the field. (R. D. Reid, A. M. Sutherland, K. C. McConnell, I. G. Montgomerie.)

Fruiting Trials

Plants of Talisman (released 1955), Redgauntlet (released 1957) and Seedling 5V322 (Auchincruive No. 30) were grown under cloches and in the open.

Plants under cloches escaped frost damage and fruit on both Talisman and Redgauntlet was ready for picking on May 30th; the heaviest crops were picked on June 6th and 11th. Redgauntlet ripened slightly later but had a shorter and more intense season than Talisman. This preliminary trial suggests that Redgauntlet may be the more suited to cloching but further trials are needed before definite recommendations can be made. Seedling 5V322 proved very susceptible to mildew when grown under cloches.

In the field, all three varieties suffered severely from spring frost. In Redgauntlet, which has an open habit of growth and a short flowering period, damage was worse than in Talisman where the flowers are protected by the foliage and the flowering period is long. Damaged flowers and unopened buds were estimated at 90% for Redgauntlet and 75% for Talisman. Fortunately many late buds developed and the crops recorded, 2 tons 13 cwt./acre for Talisman and 2 tons 2 cwt./acre for Redgauntlet, were much better than expected. Since the performance of Seedling 5V322 was only mediocre at Auchincruive, Mylnefield and the National Fruit Trials, Brogdale, this seedling has now been withdrawn. (A. M. Sutherland, K. C. McConnell.)

MYCOLOGICAL INVESTIGATIONS

Improved techniques of raising strawberry seedlings and runners for laboratory experiments with *P. fragariae* have eliminated contaminations, increased the ease of detection of visual symptoms of root infection and decreased the amount of bench space needed for plant propagation. Inocula consist of zoospore suspensions prepared from pure cultures of individual physiologic races of the fungus and precautions are taken to prevent contamination between tests.

The 36 isolates of *P. fragariae* now being studied include four new ones but all fall into one of four groups as determined by their abilities to infect the

indicator varieties of strawberry used: these are American Aberdeen, Auchincruive 11, Climax and Perle de Prague.

Nearly 3,000 seedlings were tested for reaction to *P. fragariae*; about one-third in connection with the main strawberry breeding programme, the remainder in search of new sources of resistance among the collection of varieties and *Fragaria* species introduced during the years 1954 to 1956. Altogether, 573 plants immune to the Huxley race of *P. fragariae* have been found; 241 of these were derived from selfs or crosses of resistant varieties and 332 from *Fragaria* species (*F. elatior*, *F. virginiana* and *F. ovalis*) either as runners or seedlings from selfed progenies. A large proportion of the total seems immune also to a second race of the fungus but all are susceptible to a third which infects Climax. All three races infected plants of a stock of *F. chiloensis* from Ambato, Ecuador.

Inheritance of Resistance

The results of testing seedling progenies raised from open-pollinated seed from four selections of *F. virginiana* and two of *F. ovalis* showed that the greater proportion of seedlings in each family was susceptible. However, when immune seedlings from these families were selfed, the proportions were reversed; immune seedlings occurred more frequently than susceptible ones.

When plants of commercial strawberry varieties were selfed, the proportion of immune seedlings in the progenies varied greatly; Little Scarlet selfed gave 10% and Cambridge Vigour 44% of immune seedlings. No immune seedlings have ever been found in progenies raised by selfing susceptible varieties. (I. G. Montgomerie.)

JUNE YELLOWS

Further investigations have confirmed that strawberry seedlings which initially produce chlorotic leaves may develop into plants that show forms of leaf variegation distinct from June Yellows. A proportion of seedlings raised from the varieties Early Cambridge and Cambridge Vigour produce, at certain stages of growth, leaves with pronounced variegation but growth of the plants seems unaffected.

Plants severely affected by the authentic form of June Yellows seem to produce higher proportions of yellowed seedlings than those less affected. The results of an experiment with Climax, begun in 1955 and still continuing, confirm this but show that green seedlings, when repeatedly selfed, continue to throw both yellow and green types although the ratio of green to yellow seedlings increases in each succeeding generation. (R. D. Reid, A. M. Sutherland, K. C. McConnell.)

RASPBERRY BREEDING

Work was continued with material bred in 1956 but assessment of the merits of the thornless seedling derived from Burnetholm Seedling and of other more recent selections was impossible owing to frost damage to the flowers. (R. D. Reid, A. M. Sutherland.)

METEOROLOGICAL RECORDS 1957

J. SUNDERLAND

Daily meteorological observations were made at 0900 G.M.T. throughout 1957. Weekend and holiday observations were made by the glasshouse staff.

From January 1st, 1957, the Institute agreed to participate in the Ministry of Agriculture, Fisheries and Food's Agricultural Meteorological Scheme, and the classification of the Station was changed from "Climatological Station" to "Agricultural Meteorological Station." This change involves the preparation of more detailed reports but not alterations in observational routine.

To provide data for an investigation of the epidemiology of soft fruit diseases by the Mycology Section, a recording anemometer, a recording wind direction indicator and a recording rain gauge (Dyne's tilting syphon) were

MYLNEFIELD 1957

Month	Temperature		Rainfall		Sunshine		Ground Frost
	Average* °F	Deviation† from mean	Inches	Deviation‡ from mean	Hours	Deviation† from mean	Days
Jan. ...	39·3	+1·8	2·78	+0·85	50	0	19
Feb. ...	37·7	−0·8	3·33	+1·48	98	+22	21
Mar. ...	45·3	+4·1	1·79	−0·06	62	−43	3
April ...	46·3	+1·5	0·74	−0·87	162	+22	13
May ...	48·7	−0·7	2·04	+0·04	197	+31	5
June ...	55·9	+0·6	0·95	−0·74	255	+73	2
July ...	58·2	−0·8	3·08	+0·52	116	−38	0
Aug. ...	57·0	−0·9	4·49	+1·22	120	−21	0
Sept. ...	51·5	−2·5	1·24	−0·76	121	−1	2
Oct. ...	49·4	+1·5	1·78	−0·82	88	−7	5
Nov. ...	43·2	+1·5	1·42	−0·90	51	−12	10
Dec. ...	38·7	−0·3	4·26	+1·74	61	+20	12
Year ...	47·6	+0·4	27·9	+1·70	1,381	+46	92

* Computed from daily mean of maximum and minimum temperatures at 0900 G.M.T.

† Recorded at official Dundee meteorological station 1921-1950.

‡ Recorded at official Dundee meteorological station 1881-1915.

installed during the year. The standard rain gauge is being retained for routine meteorological observations and as a check on the Dyne's instrument. Wind speed data, expressed as miles of wind in 24 hours, are now reported monthly to the Meteorological Office.

The meteorological records for 1957, from Mylnefield and Auchincruive, are summarised in the tables. The values relating to Auchincruive have been extracted from copies of the Monthly Weather Report, issued by the Meteorological Office.

AUCHINCRUIVE 1957

Month	Temperature °F	Rainfall Inches	Sunshine Hours	Ground Frost Days
January	40·9	4·17	36	11
February	39·4	1·77	89	15
March	47·6	3·39	47	0
April	47·0	2·00	182	6
May	49·5	1·60	212	4
June	56·6	1·83	289	8
July	58·3	3·25	132	0
August	57·5	4·95	110	0
September ...	51·7	4·16	115	4
October	49·7	4·13	55	6
November ...	43·7	1·89	44	11
December ...	41·1	2·67	41	18
Year	48·6	35·81	1,352	83

Averages for previous years at Auchincruive are not available.

WEATHER SUMMARY

JANUARY

Mostly very mild with several days of continuous rain during the third week, which was followed by three days of scattered snow showers; the snow did not persist.

(Highest max. 56°F on 4th
Lowest min. 24°F on 25th)

FEBRUARY

Mostly mild and wet but with long, sunny periods. The snow (0·5 in.) which fell on the 16th thawed quickly. Gales were frequent during the first week and one of force 9 was recorded on the 5th.

(Highest max. 52°F on 4th
Lowest min, 26°F on 19th and 27th)

March

Very mild and dull. Mist persisted for 21 days with thick fog on the 12th, although ten hours of sunshine were recorded on the 21st.

(Highest max. 58°F on 16th
Lowest min. 33°F on 1st and 28th)

April

Mild, dry and with long sunny periods, especially during the last week. There was a total of 17 days during which no more than a trace of rain was recorded.

(Highest max. 60°F on 30th
Lowest min. 30°F on 27th)

May

Generally cold but becoming warm, dry and sunny during the last ten days. The second and third weeks were wet with thunder and heavy showers occurring on three days.

(Highest max. 68°F on 31st
Lowest min. 30°F on 4th)

June

Unusually sunny, warm and dry. There was a total of 17 days, during which only a trace of rain was recorded.

(Highest max. 76°F on 13th
Lowest min. 35°F on 7th)

July

The first and last weeks were warm and sunny but the remainder of the month was cool, wet and dull. 1·65 in. of rain fell between the 10th and the 15th.

(Highest max. 74°F on 1st
Lowest min. 43°F on 22nd)

August

Generally cool, wet and dull throughout; 1·49 in. of rain fell on the 17th.

(Highest max. 70°F on 19th
Lowest min. 42°F on 18th and 29th)

September

Generally cool and cloudy but with bright periods; fairly dry apart from a few heavy showers.

(Highest max. 65°F on 1st
Lowest min. 33°F on 26th)

October

Warm during the first two weeks, becoming colder; fairly dry and dull throughout.

(Highest max. 62°F on 5th and 6th
Lowest min. 34°F on 24th and 28th)

November

Mild and dull. After the first week the weather became dry.

(Highest max. 55°F on 28th
Lowest min. 26°F on 7th)

December

Cold throughout. The first and last weeks were dry and the second and third wet. Scattered snow showers occurred on the 10th and 30th. Strong westerly winds blew throughout the last fortnight.

(Highest max. 54°F on 19th
Lowest min. 22°F on 16th)

VARIETY TRIALS OF VEGETABLES IN SCOTLAND

IV. Summer spinach at Invergowrie 1956-1957

C. North and L. H. Frith

Variety trials of spinach (*Spinacea oleracea* L.) grown at Invergowrie during the period 1953-55 were described in an earlier paper (North and Frith, 1956). The results of similar trials made in 1956 and 1957 are reported here.

Method

In general the trials were laid out and harvested in the same manner as before, but a modified technique was used for singling. As previous experience showed that late-sown crops of spinach sometimes fail to yield well at Invergowrie, seed for the 1956 and 1957 trials was sown in April. The seedlings were first thinned by cross working the rows with a "Planet" hoe leaving small clumps of plants 12 in. apart in the rows; the clumps were then singled by hand. This technique gave such uniform plant populations that it was unnecessary to allow for the effect of plant spacing on yield when the results were analysed statistically.

It was planned to harvest each variety when 20-25% of the plants had started to bolt (i.e., when the main stem had grown 3 in. long), but this was not always possible, since the percentage often rose overnight from well below 20 to over 25. However, as any such discrepancies in estimating the state of the crop usually represented less than one day's growth it is unlikely that they affected the yield sufficiently to alter substantially the order of varietal yield.

At harvest, in addition to the total yield, the leaf weight of ten plants, expressed as a percentage of their total fresh weight, was recorded for each plot. From this information the varietal yield of leaf was calculated.

Varieties Tested

Nine varieties which had previously given good results were grown in a yield trial in 1956. One of them, Monstrous Viroflay, gave such a poor yield that it was not retested. The other eight varieties were included again in a yield trial in 1957 together with the two strains Toftegaard and Selandia selected from the following 17 grown in observation plots in 1956: Broad Leaf (Clucas); Blatchford's New Round (Clucas); Eskimo (Ohlsens Enke, Denmark); Harrison's King (Harrison); King of Denmark (Yates); King of Denmark P52 (Ohlsens Enke, Denmark); Majestic (Woodward); Matador mørkbladet P54 (Daehnfeldt, Denmark); Mercury (Ohlsens Enke, Denmark); No. 102 (Weibull, Sweden); Selandia (Ohlsens Enke, Denmark); Standwell (Dickson); Toftegaard (Hansen, Denmark); Victoria (Clucas); Viking P52 (Ostergaard, Denmark); Viking 386 W:s 53 (Weibull, Sweden); Viroflay (Ohlsens Enke, Denmark and Zwaan and de Wiljes, Holland).

Results

Tables 1 and 2 show that, of the eight varieties tested both in 1956 and 1957, Verina and Noorman (Rijk Zwaan) yielded best. The varieties Toftegaard and Selandia, which were grown only in 1957 gave higher yields than Noorman (Table 2) but were not so productive as Verina. A careful examination of plants in the field showed that Toftegaard was indistinguishable from Verina and that plants of Selandia belonged to the Noorman-Viking group of strains.

Other varieties which gave good yields were Troubadour and two strains of King of Denmark, one from Gehlin and the other from Zwaan and de Wiljes. King of Denmark from Hurst yielded well in 1956, possibly because it was harvested at a relatively later stage of maturation than any of the other strains, for it gave a much lower yield the following year.

Discussion and Conclusions

The yields of leaf in relation to harvest dates for trials in 1954-1957 inclusive are shown in Fig. 1. Each point, within any one year, represents a different variety. These results show that there is a close association between yield and harvest date and the highly significant correlation coefficients for each of the four years confirm this. As varieties were harvested when a predetermined percentage of plants had bolted, the date of harvest indicates the varietal rates of bolting. Thus yield of leaf is closely linked with the rate at which plants of a variety bolt, a conclusion which supports the generalisation that varieties which bolt latest give the highest yields (North and Frith, 1956). The magnitude of this relationship, calculated from the information in Fig. 1, was such that a delay of one day in bolting, due to varietal characteristics, led to an increase varying from 2·4 cwt./acre in 1955 to 9·3 cwt./acre in 1956. These results suggest that it is unnecessary to measure yield directly when comparing spinach varieties, as the order of varietal yield may be deduced from estimates of the rates of bolting.

The results of the 1955-1957 trials described here, and those of the 1953-1955 trials reported earlier, emphasise the importance of choice of variety, for in each year the highest varietal yield was approximately double that of the lowest. A comparatively new variety, Verina OJO/53 from Otto J. Olson & Sons, Hammenhög, Sweden, gave outstandingly good yields during the three years it was tested. Other varieties which consistently yielded well are: two strains of King of Denmark, one from Gehlins Fröhandel, Malmö, Sweden and the other from Zwaan and de Wiljes, Scheemda, Holland; Noorman from Rijk Zwaan, Rotterdam, Holland; Troubadour from Zwaan and de Wiljes. Of the high-yielding varieties, Noorman has the best type of leaves. These may be harvested in a cleaner condition than those of most other varieties because they are held away from the surface of the soil: the outer leaves of the other three varieties usually lie on the surface of the soil. Other salient characters are the bright, rather than dark, green leaves of Verina, thick leaves of Troubadour and high proportion of petiole to leaf in King of Denmark. All the five strains mentioned are superior in several respects to most others tested at Mylnefield and may be recommended for cultivation in eastern Scotland.

TABLE I. Results of Spinach yield trial sown April 16th, 1956.

Variety (In order of yield)	Yield cwt./acre	No. of days from sowing to harvest	% "bolters" at harvest	Estimated yeild of leaf cwt./acre
*Verina OJO/53 (Olson)	235·5	72	27	143·4
*Noorman (Rijk Zwaan)	227·4	70	31	150·1
*King of Denmark Ge F/50 (Gehlin) ...	200·3	68	12	122·1
*Troubadour (Zwaan & de Wiljes) ...	163·2	67	26	112·6
*King of Denmark (Hurst)	145·7	67	35	90·3
*King of Denmark (Zwaan & de Wiljes)	142·3	64	26	92·4
*Monarch Long Standing (Hurst) ...	118·1	64	29	79·1
*Victoria (Hurst)	113·4	64	27	77·1
Monstrous Viroflay (Nutting) ...	104·9	64	27	68·1
Significant diff. (P=0·05)	18·8	—	—	—

*Varieties included in yield trials both in 1956 and 1957.

TABLE 2. Results of Spinach yield trial sown April 12th, 1957.

Variety (in order of yield)	Yield cwt. acre	Days from sowing to harvest	% "bolters" at harvest	Estimated yield of leaf cwt./acre
*Verina OJO/53 (Olson)	156·6	71	18	98·6
Toftegaard (Hansen)	145·4	71	18	90·1
Selandia (Ohlsens Enke)	118·7	67	17	79·5
*Noorman (Rijk Zaan)	111·1	67	18	74·4
*King of Denmark (Zwaan & de Wiljes)	90·7	63	22	58·9
*King of Denmark Ge F/50 (Gehlin) ...	90·3	64	10	62·3
*Troubadour (Zwaan and de Wiljes) ...	89·4	64	13	59·0
*Victoria (Hurst)	79·2	63	23	52·2
*Monarch Long Standing (Hurst) ...	78·9	63	24	52·8
*King of Denmark (Hurst)	64·9	63	18	43·4
Significant diff. (P=0·05)	18·2	—	—	—

*Varieties included in yield trials both in 1956 and 1957.

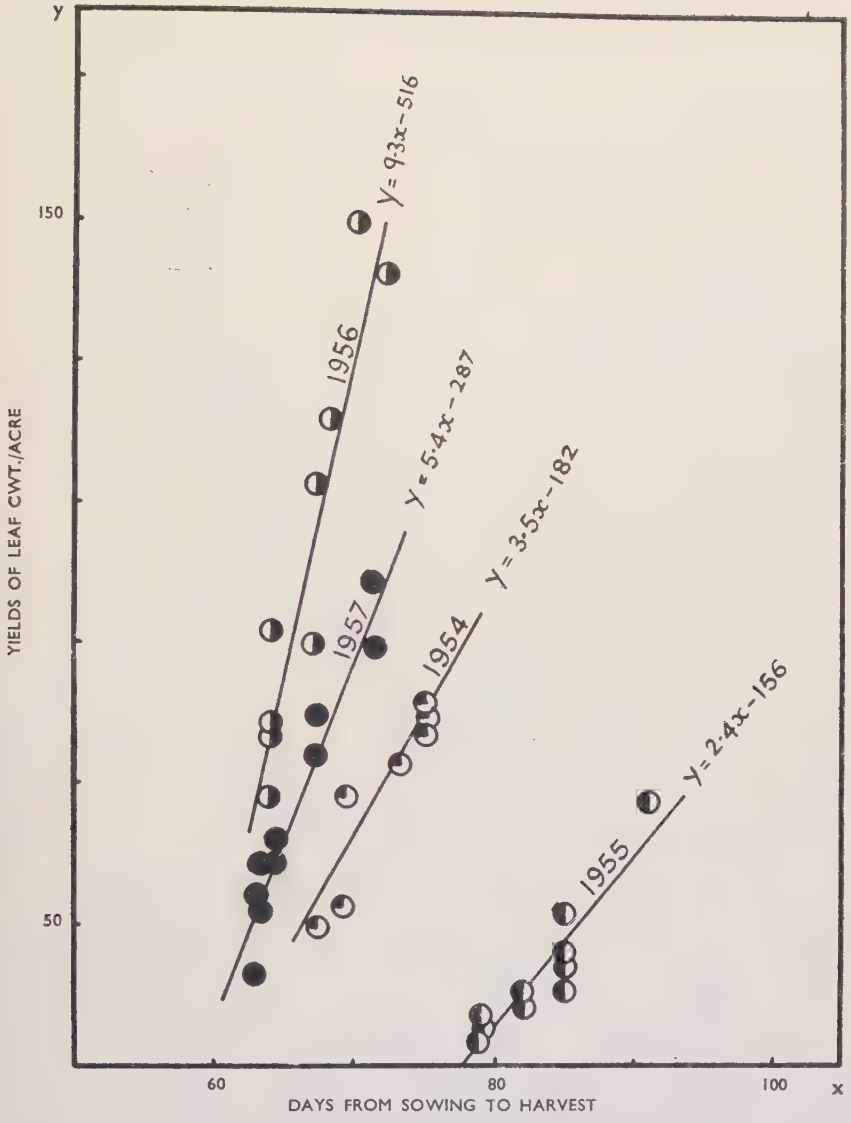

FIG. 1. Relationships between yield and harvest date.

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North, C. & Frith, L. H. 1956. Variety Trials of Vegetables in Scotland. I. Summer Spinach at Invergowrie 1953-1955. *Rept. Scottish hort. Res. Inst.*, 1955-56, 14.

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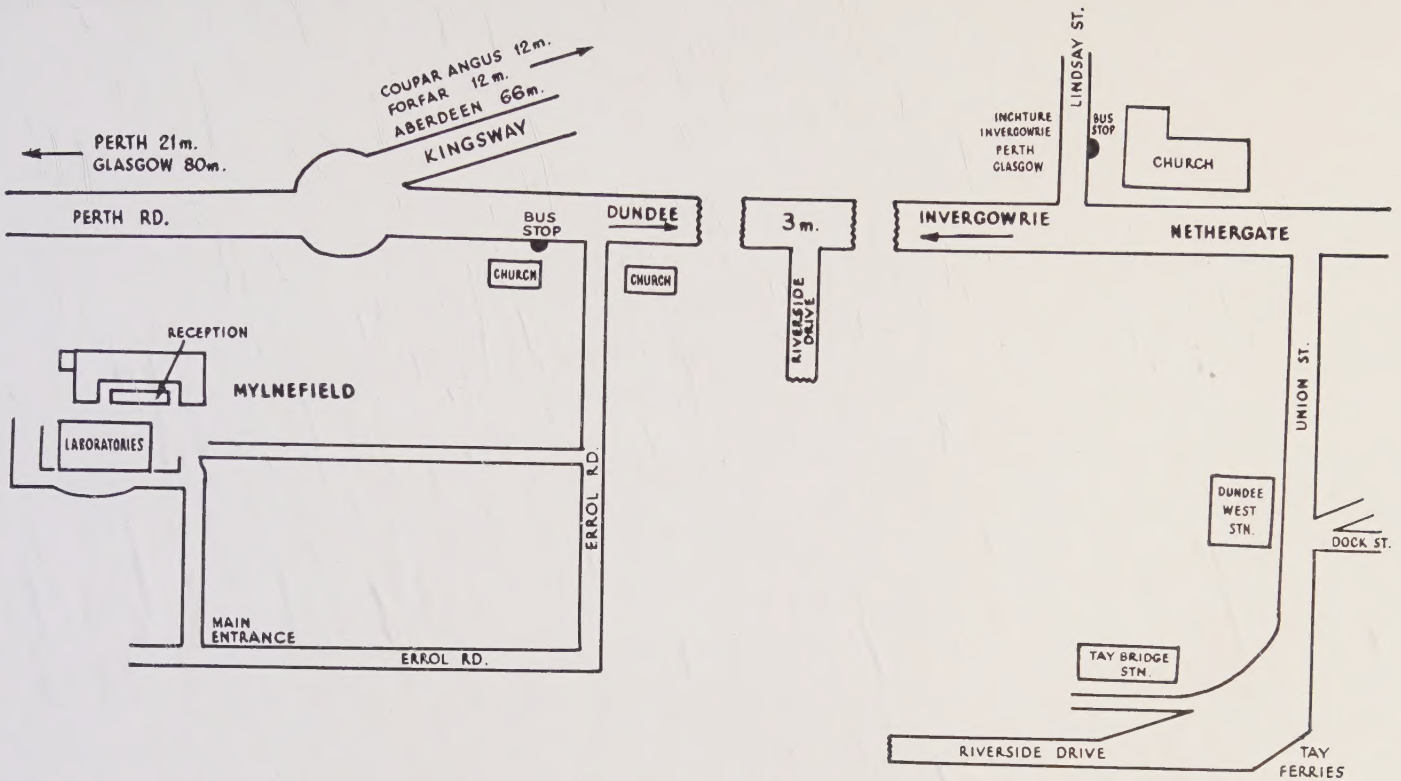

Sketch plan of routes to the Institute